Pioneering new approaches to woodland ecology and human activity in medieval Ireland (c.500-1550AD): An investigation using archaeological charcoal

Volume 1 of 1

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Declaration

I hereby declare that the work presented in this thesis is entirely my own, except where otherwise acknowledged in the text, and that this thesis has not been presented for a degree at any other University. I also agree to allow the Boole Library to lend or copy this thesis upon request.

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Abstract

The main aim of this thesis was to explore wood resource use, its impact on local woodland and the factors that influenced wood selection strategies during the medieval period in Ireland using the archaeological charcoal record. It examined the functional and cultural factors that influenced wood selection and wood use during a period of dynamic social, economic and political change and provided valuable insights into discreet local and regional patterns of how this raw material was utilised on a spatial and temporal scale. Within a multi-disciplinary framework, this research used and compared the historical, archaeological and palynological evidence to demonstrate the interpretative value of archaeological charcoal for understanding medieval woodland management and resource use.

Over 20,000 charcoal fragments were sourced from 49 archaeological excavations carried out across two landscapes located in the south-midlands through counties Tipperary (N8/M8 Cullahill to Cashel Bypass Scheme and Toureen Peckaun) and Kilkenny/Carlow (N9/N10 Kilcullen to Waterford Road Scheme). These sites represented a cross section of early medieval (fifth-twelfth AD) and later medieval (post–twelfth century AD) rural settlement and the diverse range of features typically found associated with them. Fundamental to this research was the use of saturation curve analysis, which has redefined current sample sufficiency recommendations for medieval charcoal assemblages, thus contributing to charcoal sampling methodologies in Ireland going forward. To establish if there were any distinctive patterns within the charcoal record, a number of questions were asked of the data regarding spatial and temporal use of wood, from wood selection processes for specific activities to changes in wood resource use over time.

By implementing a series of rigorous statistical tests, the results revealed that wood resource use at the beginning of the early medieval period (c.fifth century AD) was quite diverse, characterised by a rise in ash and fruitwood species, most likely reflecting the extensive period of land clearance that was underway at this time. Between the late seventh and late ninth/tenth century AD, oak use becomes sporadic shifting between being the dominant taxa to being relatively absent in the charcoal record. Wood use at a site fluctuated from being composed of an admixture of taxa

to one dominated by a single species (oak). This is interpreted as being a period when oak reserves were under pressure, during which time measures were put in place to encourage a system of resource sustainability through different forms of woodland and resource management practices. From the tenth century AD, the oak signal rises and remains high and constant into the later medieval period, at the same time other species, such as ash declines in use.

The corn drying kiln charcoal data revealed that these quintessential medieval features had a close symbiotic relationship with other on-site activities and were shown to reflect the main changes in wood use variance particularly during the early medieval period. Wood brought to a site for primary usage (construction, fencing and manufacture) was used, reused or recycled as firewood to fuel other activities, such as corn drying kilns. In addition, a novel approach comparing the charcoal and plant macrofossil assemblages from kilns provided new insights into seasonal wood use at a site. As a result, kilns may be used as a proxy for understanding and interpreting medieval wood use intimately at local level. Wood resource use was therefore culturally driven, representing the human response to a physically changing landscape largely brought about by their very actions. Bayesian chronological modelling, particularly from the corn drying kiln dataset, provided estimates for when the rise and decline in mixed wood use and oak dominance, a product of anthropogenic factors, is likely to have occurred during the medieval period. This novel approach has in turn the potential to offer new dating parameters for the beginning and end of major socio-economic and political turning points as depicted in the archaeological and historical record.

To conclude, the results of this thesis have produced a new body of critically and academically assessed environmental data for the medieval period. This study has contributed new perspectives on medieval woodland and wood use dynamics and the human response to a changing physical and socio-economic landscape. It has pioneered a statistical approach to interpreting medieval charcoal assemblages in an Irish context, highlighted how corn drying kilns can be used as a model for wood resource change at local level and by utilising Bayesian chronological modelling, has established new ways of dating major shifts in wood resource use in line with changes in the historical and archaeological record.

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I am also dedicating this work to my esteemed colleague and friend Dr Eileen Reilly who was taken from this world far too soon after a short illness on 27th July 2018. Eileen was a pioneer in her field of archaeoentomology and environmental archaeology in Ireland. A wise and beautiful soul, she is a great loss to Irish archaeology and leaves behind a formidable legacy.

Explanation of Terms

Abbreviations/Acronyms used:

AD Anno Domini

ASDU Archaeological Services Durham University

BC Before Christ

BP Radiocarbon years before present

c. Circa

cal. AD where "cal" indicates "calibrated years" before Anno Domini

cal. BP where "cal" indicates "calibrated years" before present

CIH *Corpus Iuris Hibernici*

CS *Chronicim Scotorum*

DAHG Department of the Arts Heritage and the Gaeltacht

EM Early Medieval

EMAP Early Medieval Archaeological Project

IA Iron Age

ISA Indicator Species Analysis (statistical method)

ITM Irish Transverse Mercator

LM Late Medieval

M Medieval

MCMC Markov Chain Monte Carlo (Bayesian/OxCal statistics)

MRPP Multi-Response Permutation Procedure (statistical method)

N number of counts/fragments

NGR National Grid Reference

NMS National Monuments Service

NMS Non-metric multi-dimensional scaling ordination (statistical method)

NRA National Roads Authority

PFA Percentage Frequency Analysis

PM Post Medieval

Posterior Density Dates All posterior estimates produced through Bayesian modelling are presented in *italics*

PPMCC Pearson Product-Moment Correlation co-efficient (statistical method)

RMP Record of Monuments and Places of the Archaeological Survey of Ireland, National Monuments Service, Department of Environment, Heritage and Local Government

Taxonomy All wood taxa are presented in Latin and italicized in tables and graphs. Wood species/genus are presented in Latin with English common names in parenthesis when first mentioned in the text. The English common names are then used in general text discussions.

TII Transport Infrastructure Ireland (formerly NRA)

[xxx] Context number denoting a cut feature

(xxx) Context number denoting a fill of a cut/undefined deposit or spread

Timeframes/Dates used (based on DAGH guidelines):

Iron Age	***500BC - 400AD (c. 2500 - 1600 cal. BP)***
Early Iron Age	500 - 0BC/AD
Late Irons Age	0BC/AD - 400AD
Medieval periods	***400AD - 1750AD (c. 1600BP - 300 cal. BP)***
Early medieval	400 - 1100 AD
Later medieval	1100 - 1550 AD
Post medieval	1550 - 1750 AD
Later historical	***1750 - Present AD (c. 300 - 60 cal. BP)***

List of native Irish wood taxa (Fossit 2000)

Nomenclature	**Common name**
Alnus glutinosa L. Gärtner	alder
Arbutus unedo L.	strawberry tree
Betula pendula Roth.	silver birch
Betula pubescens Ehrh.	hairy birch
Calluna vulgaris (L.) Hull	heather/ling
Clematis vitalba L.	travellers joy
Cornus sanguinea L.	dogwood
Corylus avellana L.	hazel
Crataegus monogyna Jacq.	hawthorn
Cytisus scoparius L. (Link)	broom
Euonymous europaeus L. Spindle	spindle tree
Frangula alnus Mill.	alder buckthorn
Fraxinus excelsior L.	ash
Ilex aquifolium L.	holly
Malus sylvestris (L.) Mill.	wild crab apple
Pinus sylvestris L.	Scots pine
Populus L.	poplar/aspen
Prunus avium/padus L.	wild/bird cherry
Prunus spinosa L.	blackthorn
Pyrus pyraster L.	wild pear
Quercus petraea (Mattuschka) Liebl.	sessile oak
Quercus robur L.	pedunculate oak
Rhamnus cathartica L.	purging buckthorn
Salix aurita L.	eared willow
Salix caprea L.	goat willow
Salix cinerea L.	grey willow
Salix spp	willow
Sambucus nigra L.	elder
Sorbus aria L.	whitebeam
Sorbus aucuparia L.	mountain ash/rowan
Taxus baccata L.	yew
Ulex L.	gorse/broom
Ulmus glabra L.	wych elm
Viburnum opulus L.	guelder rose

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Trees are long lived creatures which are easily and permanently altered by their environment and by human activities (Rackham 1980a, 7)

1 Introduction

1.1 Introduction

To date, there are no published historical or cartographical sources on how medieval rural settlement and agriculture impacted upon the Irish woodland (McCracken 1971, 15). Medieval settlement and activity became significantly diverse from c. fifth century AD (Kerr 2007), which inevitably put increased pressure on local woodland resources. Wood selection patterns eventually became influenced by social, economic, legal and cultural controls (O'Sullivan 1994) thus altering and reshaping the physical landscape during the course of the medieval period in Ireland.

Despite the excellent chronology supplied by documentary evidence, wood use and woodland history for medieval Ireland is discussed largely in broad terms (Rackham, 1995, 6), with information scattered throughout a variety of medieval texts and documents (Hall 1995, 24). Changes to local woodland were rarely recorded, unless they had a social or economic impact (ibid.). While archaeological waterlogged wood assemblages offer some information on specific wood selection and wood technology, wider patterns of wood use and explicit woodland management strategies for the medieval period are still unknown (O'Sullivan 1994, Tierney 1998, 56), There is also no evidence for how secondary wood growth or hedgerows developed during this time (Rackham 2000, 63). Woodland reconstruction using the medieval Irish literary records is thus highly problematic as these are often chronologically and geographically fragmented (Hall 1995, 25).

Recent palynological investigations, which tend to be the main source of evidence regarding past environmental change, have shown that more diverse woodland existed in Ireland than previously recognised (ibid). Despite this, very few palynological studies for the medieval period provide unequivocal information regarding factors affecting local woodland and seem to lack sufficient chronological resolution to identify precise rates of change (Hall 2000, 343). Regional woodland patterns are often extrapolated to local landscapes, without considering other variables, such as topography, geology and edaphic factors.

Despite the qualitative (historical) and quantitative (pollen) methods currently used for charting wood use and woodland change for medieval Ireland, an holistic approach integrating different datasets is required to elucidate many aspects of medieval woodland exploitation. Charcoal represents the only body of archaeological material that has not been coherently assessed with regard to medieval woodlands in Ireland. The unique character of archaeological charcoal represents the product of purposeful human activity within the period of site habitation (Asouti and Austin 2005, 7). This material provides a high resolution record of local woodland at a temporal scale congruent with the archaeological context itself (Nelle et al. 2010).

An increase in archaeological charcoal studies is revealing that wood exploitation was more closely dependent on local wood availability (Ludemann 2004, 2011), something that palynological analyses cannot identify in isolation. In the literary sources, no distinction is made between timber, firewood and underwood (Rackham 1995, 6), however charcoal is uniquely placed to tease out these components, thus offering new information on medieval woodland management and resource use.

The direct exploitation of woodland resources is best understood through an integrated approach which incorporates analysis of the physical wood remains themselves. This project will be the first to utilise sub-fossil archaeological charcoal assemblages exclusively from Irish medieval archaeological sites to explore the relationship between past human activity and woodland ecosystems. These assemblages represent a significant body of material recovered from commercial and research archaeological excavations in Ireland. While the analysis of archaeological charcoal in Ireland is on the rise, this data still requires proper synthesis and evaluation.

1.2 Background and justification of the research

Research into wood use and woodland for the medieval period (c.500-1550AD) in Ireland has long been sporadic and lacks a coherent analytical framework. To date, the history, use and exploitation of Ireland’s medieval woodland have been reconstructed using the historical, archaeological and palynological record (O'Sullivan 1994, 674). Despite these applications, details for specific wood selection or explicit woodland management strategies and changes to woodland dynamics at local level are still unknown. Wood selection patterns during the medieval period were heavily influenced by social, economic, legal and cultural factors, which would have inevitably impacted local woodland resources over time. Activities such as construction and firewood, although prosaic, required a frequent supply of woodland resources. The literary evidence however fails to document the individual woods used, unless it had major social or economic significance (Rackham 1995, 6). The direct exploitation of woodland resources is therefore best understood by analysing the physical wood remains themselves through an integrated approach.

Much work has been carried out on analysing worked wood and wooden artefacts preserved in waterlogged/organic/anoxic deposits (O'Sullivan 1990, O’Sullivan 1992, O'Sullivan 1994, Comey 2003, Earwood 2011, Geaney 2014) which clearly shows that people understood the properties and quality of various tree species depending on their functional and cultural needs (O’Sullivan et al. 2013, 234). Despite these valuable contributions to the study of medieval wood and wood working in an Irish context, these assemblages represent a selection bias and cannot, in isolation, be a true reflection of wood resource use during this time. Charcoal is therefore uniquely placed to offer new insights into medieval woodland management and resource use and ultimately how the composition of local woodscapes altered over time.

Charcoal represents the only body of archaeological material that has not been coherently assessed to date with regard to medieval wood use and woodland change (Kerr et al. 2012). Over the last twenty years, the upsurge in archaeological excavation in Ireland has produced a large quantity of identified and unidentified charcoal assemblages which is mostly confined to the grey literature of archaeological reports. As one of the most commonly recorded remains recovered from archaeological sites, it is still the most neglected and under-researched (Tierney 1998, 56, Timpany et al. 2018, 201) despite significant improvements in methodological and sampling procedures (Dufraisse 2006). The unique character of archaeological charcoal represents the product of purposeful human activity and gives a high–resolution picture of local woodland congruent with the archaeological context itself (Nelle et al. 2010, 2127).

This project will be the first to use charcoal assemblages from Irish medieval archaeological sites to explore the relationship between past human activity and woodland ecosystems. In addition, this exploration, will contribute to understanding the nature and characteristics of different medieval settlements and activities based on their wood resource management strategies. Within a multi-disciplinary framework, this research will use comparable historical, archaeological and palynological evidence to demonstrate the interpretative value of archaeological charcoal for medieval wood resource use and how it can aid woodland reconstruction for this period. A novel use of Bayesian chronological modelling, an application still in its infancy in Irish archaeology, will also be implemented to refine and redefine site chronologies and sequences of activity to interpret the charcoal record more rigorously. Research on medieval wood use and woodland through charcoal will therefore strengthen current wood and charcoal studies in Ireland by providing a new set of data for medieval archaeological and environmental research.

Charcoal analysis has a considerable amount to add to the Irish archaeological record and through this empirical research, understanding medieval wood use will help answer some fundamental questions about wood selection patterns, management strategies and the factors that influenced these over the course of time. This research will also pioneer new models for understanding past wood management dynamics, contribute to existing proxies for woodland reconstruction and be uniquely placed to provide a more rigorous theoretical grounding for future archaeological, historical and palaeoecological integration. Considering the phenomenal amount of research into the archaeology of medieval Ireland in recent years this project will be a timely and significant addition to this rich archive.

1.3 Study areas and sample sources

The study area for this thesis includes a series of rural medieval settlement sites and activities excavated in County Tipperary (N8/M8 Scheme and Toureen Peckaun) and County Kilkenny/Carlow (N9/N10 Scheme) both located in the south midlands of Ireland **(Figure 1.3.1).** The section of the N8/M8 Cullahill to Cashel road scheme selected for study consists of a 35km route extending from Two-mile Borris, Co. Tipperary southward to Owen’s and Bigg’s Lot, approx. 2km south of Cashel town, Co. Tipperary **(Figure 1.3.2).** In addition, the research excavation at Toureen, Peckaun situated approx. 20km southwest of Cashel town was also included in this study (Ó’Carragáin 2006; 2008).

The section of the N9/N10 Kilcullen to Waterford road scheme selected for study consists of a 50km route extending from Moanduff, Co. Carlow approx. 15km northeast of Kilkenny City to Milltown located approx. 35km south of Kilkenny City **(Figure 1.3.3).** Both areas facilitated this study through the rich medieval landscape that existed, where a cross section of secular and ecclesiastical rural settlements were recorded, defining the social structures that characterised rural medieval Ireland from the fifth to the fifteenth century AD. A total of 49 sites dating to the Early Medieval (c. 400-1200 AD) and Late Medieval (c.1200-1550 AD) periods are included in this study **(Table 1.3.1).** Thirty three of the sites were analysed by the author as part of the post-excavation stage of archaeological works, the results of which form part of the final report for each site. The remaining sixteen sites were analysed by Dr Ellen O Carroll, the results of which are included in this study. This thesis incorporates all the charcoal results from these sites which are merged and discussed within a specific research framework.

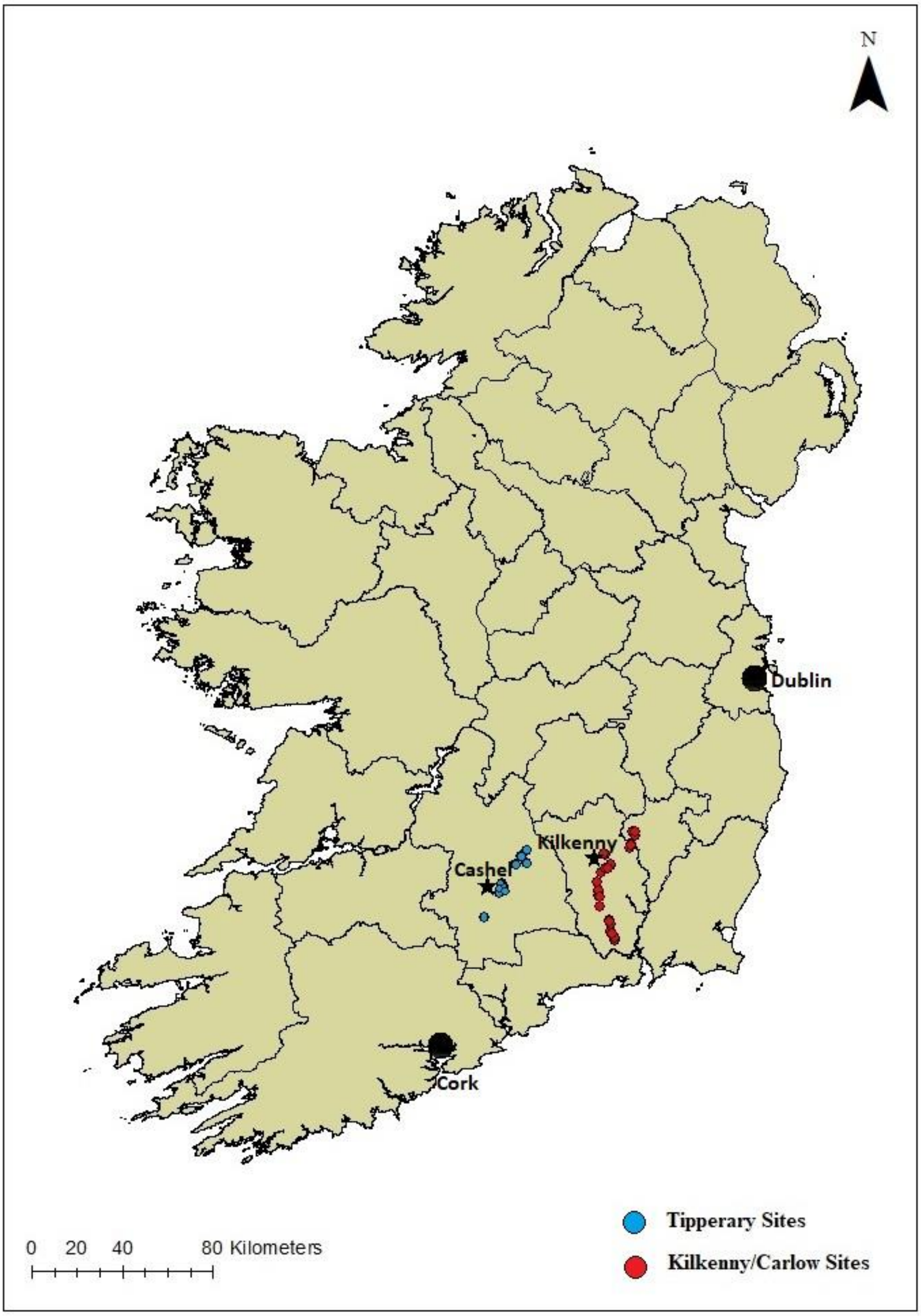


Figure 1.3.1 Location of studied sites in Co. Tipperary and Co.Kilkenny/Carlow

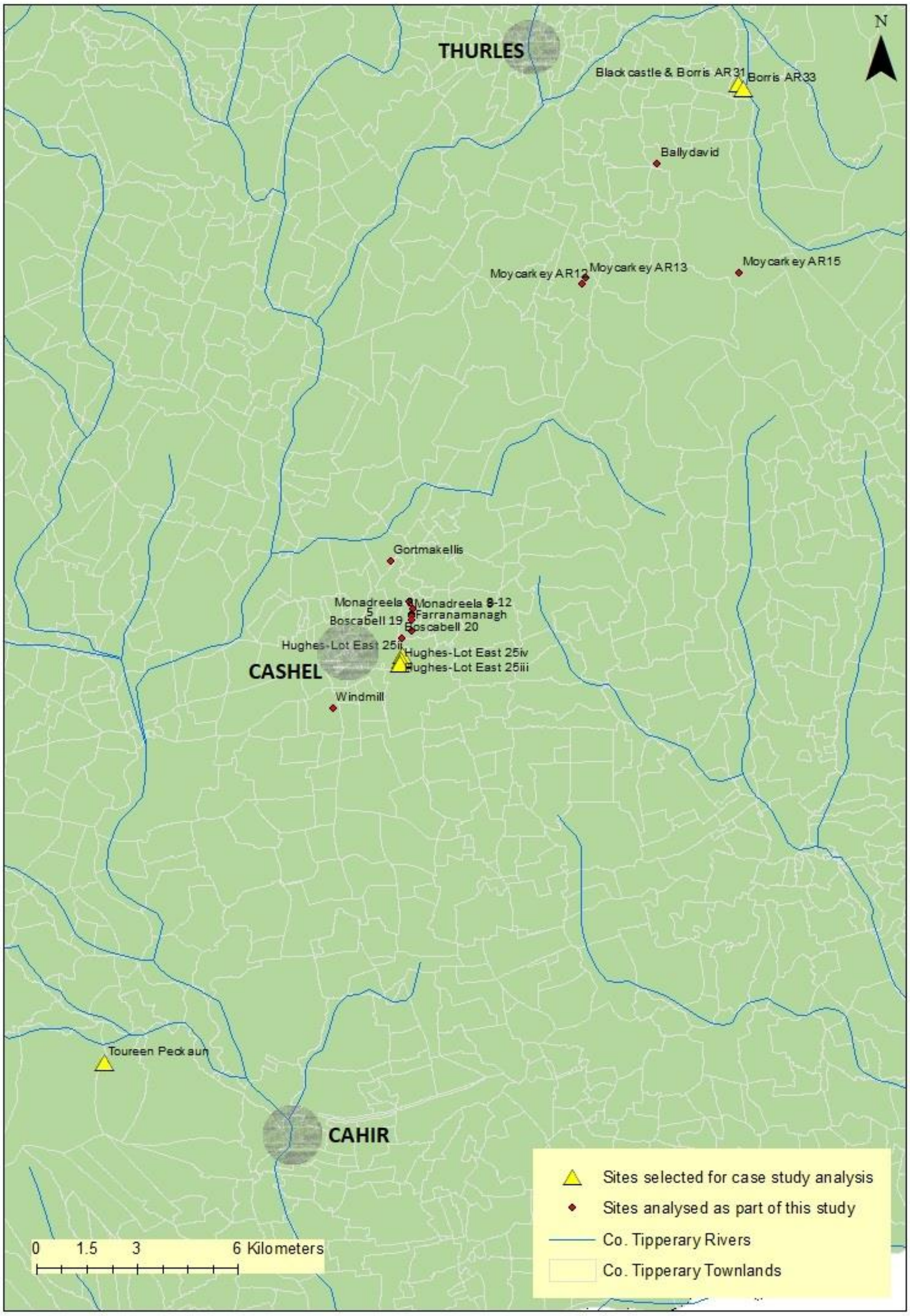


Figure 1.3.2 Location of sites analysed from Co. Tipperary

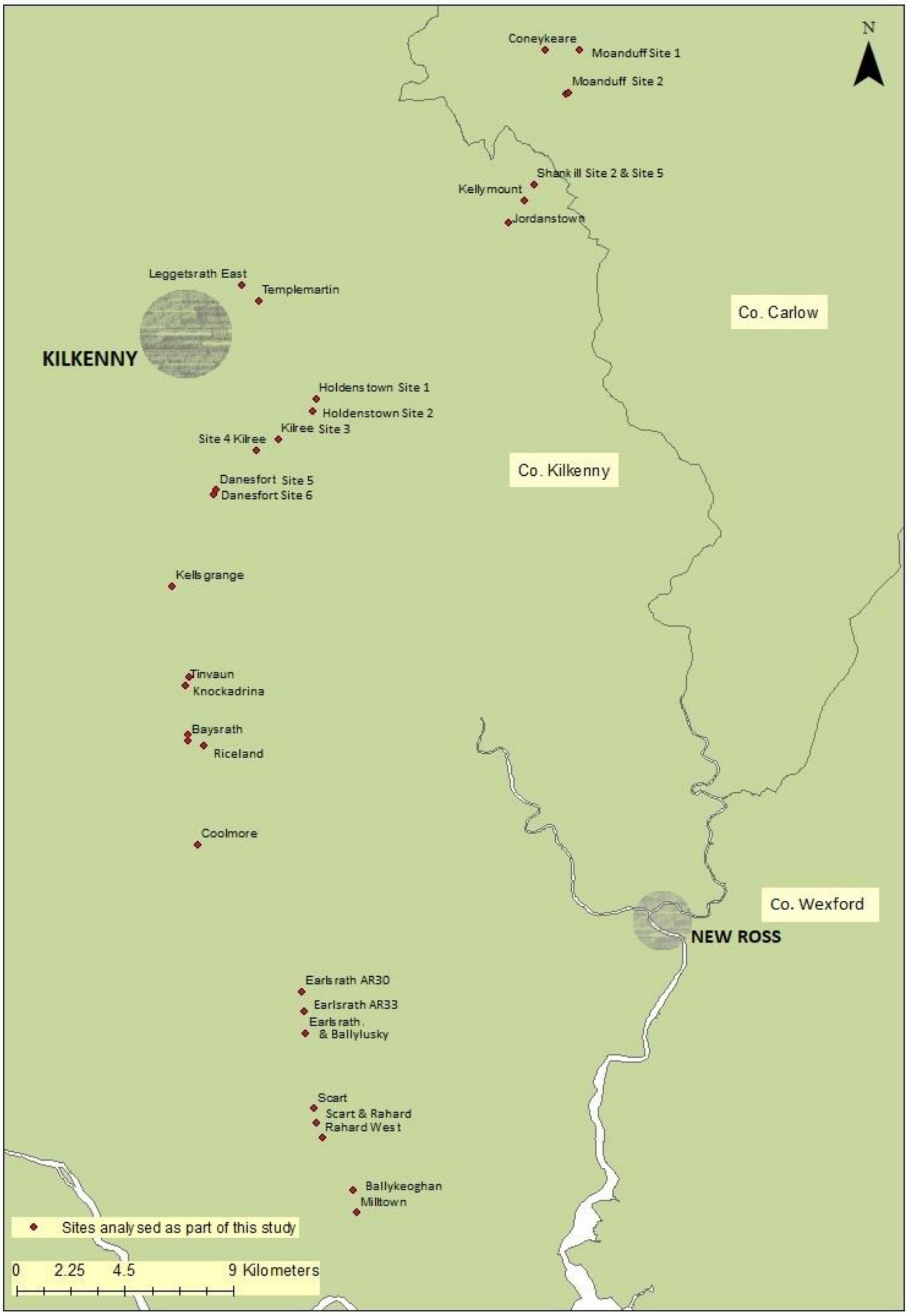


Figure 1.3.3 Location of sites analysed from Co. Kilkenny/Carlow

Table 1.3.1 List of sites in this study

County	Site name	Site type	Time period	Time period
Carlow	Moanduff Site 1 AR137	Pits	Early medieval	400-800 AD
Carlow	Moanduff Site 2 AR155	Industrial: Kiln/Furnace	Early medieval	400-800AD
Carlow	Coneykeare Site 1 AR138	Enclosed settlement	Early medieval	400-800AD
Kilkenny	Baysrath AR53/54	Settlement complex/cemetery	Early medieval	400-800 AD
Kilkenny	Tinvaun Site 3 AR66	Pits	Early - High medieval	800-1200 AD
Kilkenny	Knockadrina AR68	Enclosed settlement	Early medieval	400-800 AD
Kilkenny	Kellysgrange Site 3 AR73	Industrial: Corn drying kiln	Early medieval	400-800 AD
Kilkenny	Holdenstown Site 1 AR96	Enclosed settlement	Early medieval	400-800 AD
Kilkenny	Holdenstown Site 2 AR98	Cemetery settlement	Early medieval	400-800 AD
Kilkenny	Danesfort Site 5 AR82	Pits	Early medieval	400-800 AD
Kilkenny	Danesfort Site 6 R83	Occupation	Late medieval	Post 1200 AD
Kilkenny	Kilree Site 3 AR93	Cemetery settlement	Early medieval	400-800 AD
Kilkenny	Kilree Site 4 AR94	Enclosed settlement	Early medieval	400-800 AD
Kilkenny	Templemartin AR152	Industrial: Corn drying kiln	Early medieval	400-800 AD
Kilkenny	Kellysmount AR58	Pits	Early medieval	400-800 AD
Kilkenny	Milltown AR03-05	Industrial: Kiln/Metal	Early medieval	400-800 AD
Kilkenny	Ballykeoghan AR10-12	Industrial: Corn drying kiln	Early medieval	400-800 AD
Kilkenny	Jordanstown AR120 Site 2	Pits	High medieval	800-1200 AD
Kilkenny	Scart AR20	Industrial: Corn drying kiln	High medieval	800-1200 AD
Kilkenny	Shankill Site 2 AR128	Industrial: Corn drying kiln	Late medieval	Post 1200 AD
Kilkenny	Shankill Site 5 AR131	Pit	Late medieval	Post 1200 AD
Kilkenny	Leggetsrath East AR154	Occupation	Late medieval	Post 1200 AD
Kilkenny	Scart & Rahard AR19	Industrial: Corn drying kiln	Late medieval	Post 1200 AD
Kilkenny	Coolmore AR44	Industrial: Corn drying kiln	Late medieval	Post 1200 AD
Kilkenny	Earlsrath AR30	Ditch	Early medieval	400-800 AD
Kilkenny	Earlsrath AR33	Ditch	Late medieval	Post 1200 AD
Kilkenny	Earlsrath & Ballylusky UTA4	Metal working	Early medieval	400-800 AD
Kilkenny	Rahard West AR17-18	Occupation	High medieval	800-1200 AD
Kilkenny	Riceland AR01	Ditch	High medieval	800-1200 AD
Tipperary	Ballydavid AR26	Industrial: Corn drying kiln	Early medieval	400-800AD
Tipperary	Moycarkey Site 12	Occupation	Early medieval	800-1200 AD
Tipperary	Moycarkey Site 13	Pits	Early medieval	800-1200AD
Tipperary	Moycarkey Site 15	Iron working	Late medieval	Post 1200 AD
Tipperary	Borris AR33	Enclosed Settlement	Early - Late medieval	400-1200 AD
Tipperary	Borris & Blackcastle AR31	Industrial: Kiln/Metal/Mill	Late medieval	Post 1200 AD
Tipperary	Gortmakellis AR01	Enclosed settlement	Early medieval	800-1200 AD
Tipperary	Monadreela Site 5	Industrial: Corn drying kiln	Early medieval	400-800 AD
Tipperary	Monadreela Site 8	Enclosed settlement	Late medieval	Post 1200 AD
Tipperary	Monadreela Site 9	Enclosed settlement	Late medieval	Post 1200 AD
Tipperary	Monadreela Site 11	Enclosed settlement	Early - Late medieval	800-1200 AD
Tipperary	Monadreela Site 12	Enclosed settlement	Late medieval	800-1200 AD
Tipperary	Boscabell Site 19	Enclosed Settlement	High medieval	800-1200 AD
Tipperary	Boscabell Site 20	Enclosed Settlement	Early medieval	400-1200 AD
Tipperary	Hughes-Lot East Site 25ii	Enclosed settlement	Early - High medieval	400-1200 AD
Tipperary	Hughes-Lot East Site 25iii	Enclosed settlement	Early medieval	400-800 AD
Tipperary	Hughes-Lot East Site 25iv	Enclosed settlement	Early medieval	400-800 AD
Tipperary	Farranamanagh Site 40	Industrial: Metal/furnace	Early - High medieval	800-1200 AD
Tipperary	Windmill Site 35	Pits	Late medieval	Post 1200 AD
Tipperary	Toureen Peckaun	Monastic settlement	Early - Late medieval	400-1200 AD

1.4 Study objectives and approaches

This thesis aims to provide a more comprehensive understanding of the role of wood as a resource during the medieval period in Ireland through the analysis of archaeological charcoal. It examines the functional and cultural factors that influenced wood selection and wood use during a period of dynamic social and economic change and establishes discreet local and regional patterns of how this raw material was utilised on a spatial and temporal scale. This aim is achieved through the following objectives:

1. Combining data on charcoal derived from samples excavated from a range of archaeological sites representing rural medieval settlement and occupation within the study areas of counties Tipperary and Kilkenny/Carlow
2. Using charcoal from context-related activities representing primary and secondary deposition (e.g. structural deposits, corn drying kilns, metalworking and charcoal production pits, hearths, ditches, souterrains and unclassified pits) to identify comparable and contrasting patterns within the datasets
3. Using Bayesian modelling to refine site and feature chronologies for a more robust interpretation of the dataset on a temporal scale
4. Evaluating the success of the methodologies adopted to provide explanatory models for medieval wood use based on archaeological charcoal analysis

Meeting these objectives will help to answer the following questions:

1. Does wood use and wood selection practices change from the early medieval to the late medieval period
2. Is change in resource use linked to changes in the socio-economic landscape of the medieval period and how is this reflected in the archaeological and historical record
3. Are certain wood taxa used for particular site activities and why
4. Is there a selection bias at play on individual sites and if so what factors influence this

5. Can the wood data provide additional evidence for the presence of managed areas, including gardens or orchards
6. Can Bayesian modelling be used to improve the accuracy of site activity to allow for a more rigorous discussion of the dataset within an archaeological timeframe

1.5 Structure of the thesis

This thesis is divided into six chapters. **Chapter 1** introduces the thesis and the scope of the archaeological research within the context of medieval Ireland. It will present the historical, archaeological and palaeoecological background to woodland and wood use for the medieval period and the current viewpoints that exist on this elusive subject. In **Chapter 2,** the author reviews the use of charcoal in an archaeological context and presents and critiques current methodological practices, which introduces the best approaches for this thesis. **Chapter 3** discusses the various quantitative methods used in this research, with regard to sample selection, fragment count and the suite of statistical tools employed to facilitate a robust interrogation of the dataset. **Chapter 4** presents the overall results of the analysis, by site, by feature and chronologically between the early and late medieval period (c.500-1550 AD).

To confirm how the trends and patterns observed in Chapter 4 are represented at local level, the charcoal results from a series of case studies are presented in **Chapter 5. Chapter 6** deliberates the results in context, in line with existing historical, archaeological and palaeoenvironmental data, to discuss medieval wood use at local and landscape level and how it fits with broader charcoal datasets. It discusses the main trends in wood resource use and supply chronologically for medieval Ireland; how this dataset can be used to model on-site activities and the contributions that charcoal analysis has made to further our understanding of wood resource use, woodland dynamics and its human impact during this period. To conclude, a review of the major findings, their relevance to the archaeological and historical record including future work is summarised.

1.6 Medieval Ireland: archaeological research and review

1.6.1 Introduction

The medieval period in Ireland in one of the most extensively researched areas from an Irish archaeological and historical perspective. The complexities and diversity of medieval settlement that developed from the fifth century AD in Ireland is largely discussed within the cultural, social and economic structures that defined this period as reflected through the archaeological and historical record. This section serves to provide a brief overview of the main agendas that have dominanted Irish medieval archaeology to demonstrate the diversity of research that has been undertaken to date, much of which continues to fascinate scholars of medieval studies. Furthermore and in keeping with the main theme of this thesis, the role of wood, woodland and woodland management will be examined using the archaeological, paleoenvironmental and historical record so that this research can be placed in its rightful context.

1.6.2 Past and present research agendas

Early Irish historical sources dating from the seventh and eighth centuries AD, such as the laws, saints' lives, narrative literature and manorial accounts from estates and monastic houses from the thirteenth century have traditionally provided the main source of information regarding daily life in medieval Ireland. The seminal works of Kuno Meyer (1906a) Myles Dillon (1948), Daniel Binchy (1970, 1978), Mac Airt, and Mac Niocaill (1983), and Fergus Kelly (1988, 1997, 1998) in translating many early Irish annals, documents and legal tracts have been instrumental in providing a glimpse into early Irish life and detailing major events on a calendrical scale.

Many different approaches are now been used to increase our awareness and understanding of the medieval period in Ireland. Paramount to this has been archaeological excavation over the past two centuries, where improvements in methods, techniques and theories have emerged to transform and illuminate this complex yet fascinating period in Ireland (O'Sullivan et al. 2013, 13, Stout 2017). This practice has been further advanced with the increase in the quality and range of scientific techniques now employed, particularly with the expansion of major development schemes which began in the late 1990's (O'Sullivan et al. 2013, 26).

This recent development-led boom in archaeological investigation has provided a source of information that is facilitating a new wave of data collation, synthesis and interpretation, which is increasing our knowledge of medieval and particularly early medieval Irish society, settlement and landscape. One such project which has successfully brought together this vast archive has been the *Early Medieval Archaeological Project (EMAP)* (http://www.emap.ie/) (O'Sullivan et al. 2013). This rich resource contains the largest medieval archaeological bibliography on a scale that is unparalleled anywhere in the world and with its accompanying thematic papers, provides explicit insights into medieval daily life as depicted through the archaeological record, along with highlighting the research questions that still need to be addressed.

The medieval period in Ireland has long been the focus of scholarly interest, and many publications exist describing the classic site types, their domestic and industrial activities and their socio-economic ideologies (De Paor and De Paor 1958, Mac Niocaill 1972, Mytum 1992, Edwards 1996, O'Sullivan 1998, Stout 2000, Stout 2017, Charles-Edwards 2000, Fredengren 2002, Curtis 2012, O'Sullivan et al. 2013, Cróinín 2016). This includes the emergence and development of monastic towns (Doherty 1985, Bradley 1998, Swift 1998) during the eighth and ninth century; the arrival and influence of the Viking age culture into Ireland during the ninth and tenth centuries (Hurley et al. 1997, Clarke 1998, Wallace 2005, Valante 2008) the impact of the Anglo-Norman settlement and colonisation during the twelfth and thirteenth centuries (O'Keeffe 1996, Barry 2002, Edwards and Nicholls 2004, Cosgrove 2008) and the insular response by Gaelic Ireland during this time (O'Conor 1998, Simms 2000, Edwards and FitzPatrick 2001, Nicholls 2003, O'Keeffe 2004).

The history and archaeology of how and when Christianity and the church structure emerged in medieval Ireland has also garnered attention, initially through the work of art historians and architects (Champneys 1910, Henry 1967, Henry 1970, Harbison 1999) and, more significantly, by the changing ideologies brought about through archaeological excavations in recent years (O'Kelly 1957, Fanning 1981, Sharpe 1984, Marshall et al. 2005, Ó'Carragáin 2010). The reforms and introduction of the diocesan system in the twelfth century (Hughes 1966, Etchingham 1999) have also been addressed and with an increase in research and excavations, particularly from Cistercian abbeys (Bradley et al. 1981, Lynch 2008, Lynch and Baillie 2010, Stout 2016) a more illustrative picture of later medieval monastic life in Ireland is now more attainable.

Underpinning this diverse and complex pattern of changing medieval settlement was a socio-political structure initially based on kinship, gender relations and hierarchy, which emerged during the early medieval period (Kelly 1988, 1997, Charles-Edwards 1994, O' Corráin 1995, Ó Corráin 2002). In recent years there has been renewed focus and research into the pivotal role of centralised kingship and its ideology in early medieval Irish society (Bhreathnach 2014), a subject which has moved from having a theoretical grounding to one now being represented in the archaeological record with the identification of *óenach* assembly sites (Bhreathnach 2005, Gleeson 2012, 2014, 2015).

Archaeological excavations are revealing the complexities of early medieval settlements, which have challenged and redefined the traditional models of how medieval communities lived, worked and buried their dead (Coyne 2005, Seaver 2016). Medieval settlements are now focusing on their contemporary social and economic position within a broader landscape setting (Stout 1997, Kerr 2007). Fundamental to understanding these processes, is the study of the material culture that represents these activities. The rich artefactual assemblages emerging from these excavations has allowed for a more nuanced approach to studying archaeological finds and the processes that served to produce them. There is now a shift from the antiquated approach of cataloguing artefacts based on size and typology, which considered only the finished product, to one which explores the discipline of things - how people used objects, be it through sourcing, manufacturing, utilising or trading different materials that prescribed behaviour and shaped the world around them.

There has always been a keen interest in medieval craftworking (Edwards 1996, Ryan 2002, Wallace 2005), however, a review of crafts in context including evidence for their manufacture (Comber 2008) - e.g. Deer Park Farms, Co. Antrim (Lynn and McDowell 2011); Drumclay Crannóg, Co, Fermanagh (www.medievalists.net/2014/09/6000-artefacts-discovered-drumclay-crannog-dig/) and the Viking settlement in Waterford City (Hurley et al. 1997) – is providing new information on the technical processes used in various craftwork and the society that they represented. In turn, this has allowed archaeologists to reflect on the social ideology of medieval dwellings, how space was organised and the factors that influenced the changing needs of a household over time (Moore 1986, 91-106, Brück 1999, O'Sullivan 2008, O'Sullivan and Nicholl 2011). The approach to interpreting metalworking activities (both ferrous and non-ferrous) is also under revision. Previous studies (Scott 1991, Edwards 2013) failed to make the distinction between smithing and smelting for example, or lacked a viable methodology to aid in the analysis of metalworking debris.

While the historical evidence gives specific details on the practices and duties performed by smiths within the forge (Scott 1983), the nature of where and when these smiths carried out their work has been subject to much debate, from a centralised model (Mytum 1992) to a hypothesis based on transient itinerant blacksmithing (Dyer 1989) being put forward. The metallurgical evidence from recent excavation schemes in Ireland has allowed discussions by archaeologists and archaeometallurgists on the regional patterns and the various levels of metalworking found on early medieval sites (Carlin 2008, 87-112; Wallace and Anguilano 2010). Despite this however, excavations have revealed considerable variability in the extent and character of evidence from various forms of settlements (Kerr et al. 2012). An increase in specialist metallurgical work in recent years has contributed greatly to this subject, where the different stages of ironworking, including fuel procurement and charcoal production can now be classified in a more systematic way (Photos-Jones 2008a, 2008b, Carlin 2008, Wallace 2010b, Kenny 2010, Dolan 2012, Rondelez 2014).

A new approach on the rise to understanding past techniques and methods based on archaeological source materials is experimental archaeology. This field of study attempts to generate and test archaeological hypotheses, by replicating or approximating the feasibility of how past communities carried out specific tasks and general duties. Since 2012 the Centre for Experimental Archaeology and Material Culture (https://www.ucd.ie/archaeology/ceamc/) at University College Dublin has been engaged in designing and creating various aspects of medieval settlement, from constructing early medieval and Viking Age houses; reproducing the processes of pottery manufacture; bronze, iron and glass-working; food production and processing and through the use of entomology (beetles) the various micro-climates that existed in and around a medieval settlement have also been reconstructed. This tactile approach to understanding living standards and conditions in the past is fast becoming an innovative and nuanced way of researching not just prosaic domestic and industrial activities, but human behaviour and the role of crafts, technologies and materiality in their daily lives.

1.6.3 Bayesian chronological modelling

Pivotal to this thesis is the use of Bayesian chronological modelling, which is used to provide a more robust chronological sequence of dates to improve the accuracy of site activity, which will allow for a more rigorous discussion of the charcoal dataset within a refined archaeological timeframe. The following sections will present an overview of the relevance of this tool in an archaeological context and its current uses for the medieval period.

Background to the method

While the simple calibration of radiocarbon dates are accurate estimates for dating samples, this application does not offer explicit information for the beginning, end or duration of archaeological activity. Over the last number of years, the interpretation of archaeological data using bayesian statistical methods are now being used to improve the accuracy and precision of the chronology of activity at a site within an archaeological timeframe. As expressed by Bayliss et al. (2007) 'The importance of chronology is reasserted as a means to achieving history and a sense of temporality.' This method can be used to investigate a series of chronological questions, such as the start and end dates of activity, the duration of activity and more specific questions such as sequences of activity (Buck et al. 1994, Bayliss et al. 2007).

Pioneering work by Naylor and Smith (1988) developed tools for chronology building within a Bayesian framework, focusing on the calibration and interpretation of radiocarbon data. Using the Iron Age hillfort at Danebury in Hampshire, England, they implemented a model which took account the various uncertainties of radiocarbon determinations of artefacts related to successive chronological start and end dates for significant phases of activity (ibid.). While this approach was a major contribution to interpreting radiocarbon determinations, it contained technical errors and did not take into account the variability of archaeological deposition and stratigraphy. In an attempt to present this model in an archaeological framework, it was reviewed and encouraged subsequent works using a more robust framework (Buck et al. 1991, Buck et al. 1992). In more recent works (Bayliss et al. 2007, Whittle et al. 2011) the Bayesian approach to chronological modelling in archaeology has further emphasised the rigorous application of using both archaeological and scientific methods together.

Bayesian modelling in recent archaeological projects

Bayesian modelling has revolutionised archaeological dating methods in recent years, as demonstrated by the seminal publication of *Gathering Time* (Whittle et al. 2011). In an attempt to re-evaluate the extent, nature, timing and impacts of certain events, a review of archaeological and palaeoenvironmental evidence is on the increase. To underpin these strands of evidence, Bayesian chronologies are fast becoming a significant part of new dating programmes, as evident from the INSTAR project *Cultivating Societies: assessing the evidence for agriculture in Neolithic Ireland* (www.chrono.qub.ac.uk/instar) (Whitehouse et al. 2014) and the work undertaken at Sutton Common, Yorkshire (Gearey et al. 2009). Current applications in Ireland and Britain focus primarily on modelling and remodelling the chronology of Mesolithic, Neolithic and Bronze Age sites (Whittle et al. 2008, McSparron 2008, Bayliss and Woodman 2009, Schulting 2011, Marshall et al. 2013, Schulting et al. 2017). It has also been used to establish the chronology of how adversely human activity was impacted upon during the Iron Age lull in Ireland (Coyle McClung 2013).

Bayeisan modelling for the medieval period

Bayesian modelling is generally used infrequently as a chronological tool in a medieval context. Primarily, this is because the uncertainly of calibrated dates provides little advantage over historical sources and traditional archaeological dating for this period. An *English Heritage* project undertaken to refine Anglo-Saxon chronologies based on typology of artefacts implemented this approach with some success (McCormac et al. 2008). A Bayesian framework was successfully used at three Viking Age and medieval sites in Iceland (Batt et al. 2015) The approach proved very useful in not only allowing a more nuanced understanding of occupation and abandonment, but the use of models to propose sequences of activities where stratigraphic relationships are missing (ibid.).

In Ireland, the use of Bayesian in-depth modelling for the medieval period still remains untested for the most part. One area of interest that has garnered the most attention is the chronology of raths or ringforts, the archetypical settlement type of the early medieval period in Ireland. Early attempts at analysing and synthesising early medieval radiocarbon dates were able to represent through the individual probability plots, the start, end and peak construction periods of these features (Stout 1997, Kerr 2009). Issues with the calibration curve using 2-sigma probability dates rendered the results dubious however. To further refine these parameters, recent work by Kerr and McCormick (2014) implemented a Bayesian approach, which, to date represents the only synthesis of medieval radiocarbon data using this framework. While the use of Bayesian analysis in archaeology is still in its infancy, the implications of it for the medieval period still remains unexplored and this thesis serves to demonstrate how it can be further used to advance our knowledge for when significant changes in activities occurred during the historic period.

1.6.4 Environmental archaeology

Environmental archaeology has also played a significant part in contributing to medieval research in recent years, the most influential being archaeobotany and zooarchaeology (McCormick 1992, McCormick 2002, McCormick 2008, McCormick et al. 2011, McClatchie et al. 2015a). While the early Irish documentary sources provide a wealth of information on the cultivation of crops and food plants, along with animal husbandry practices (Kelly 1997), this is further augmented by the analysis of plant macrofossils and animal bone remains from Irish medieval sites (Geraghty 1996, McClatchie 2011, McCormick et al. 2011, Lyons 2012, Lyons 2015a). Furthermore, the use of entomology is proving to be a valuable tool in recreating the micro-climate of living conditions in the medieval period, and the intimate environmental changes that occurred in human and animal activity using the archaeological insect record (Reilly 2003b). The extensive analyses of these assemblages have provided valuable information on geographical and chronological changes to medieval arable and pastoral economies, along with insights into the social status and functionality of medieval settlements.

The pollen record for medieval Ireland is somewhat disappointing on the other hand. Published pollen sequences for the medieval period are few, if they survive, and are discussed largely on a site by site basis (Hall 2003, 2006, Lomas-Clarke and Barber 2004, Overland and O'Connell 2011) with fewer still providing any details for regional or landscape change (Molloy 2008, O Carroll 2012). The rate and scale of diverse settlement underway during the medieval period as depicted through the archaeological record, is not, at present, supported by the palynological data (O'Sullivan et al. 2013, 180).

Pollen analysis techniques can rarely identify changes between grassland and arable farming for example and while periods of woodland regeneration and clearance can be deduced, these profiles cannot be independently dated. Despite this, very few palynological studies for the medieval period provide unequivocal information regarding factors affecting local woodland and seem to lack sufficient chronological resolution to identify precise rates of change (Hall 2000, 343). Regional woodland patterns are often extrapolated to local landscapes, without considering other variables, such as topography, geology and edaphic factors. Oak and hazel, both producers of large quantities of pollen grains, are moreoften over-represented in the pollen record, while values for insect-pollinated species, such as willow and the fruitwood species (Maloideae) can become lost or marginalised.

Just one study exists from Ireland which compares the pollen record to contemporary archaeological wood and charcoal datasets for past woodland reconstruction. O Carroll's (2012) research along the N6 Kilbeggan to Kinnegad road scheme (through counties Meath, Westmeath, Offaly and Roscommon) clearly highlights the problems faced when comparing these two datasets, where distribution of woodland and anthropogenic activities varied from region to region (O Carroll 2012, 227). The spatial relationship of the pollen core to an archaeological site is imperative (i.e the closer the better) to obtain an accurate profile of woodland vegetation and its changes over time (ibid. 229). This makes interpreting pollen in an archaeological context difficult as it does not take into account the various anthropogenic or taphonomical factors that influence these environmental assemblages **(see Chapter 2; Section 2.5).** An increase in the use of palaeoenvironmental proxies, such as ice-core analysis and tephra, used in conjunction with documentary sources is also providing new insights into the rates of climatic change during the medieval period and its impact on human behaviour, settlement and societal structures during this time (e.g. Hall 2003, Turney et al. 2006, Kerr et al. 2009, Swindles et al 2010, Ludlow 2005, 2006, 2012). The medieval period is proving to be of particular interest with regard to these datasets, where a greater disparity exists between the pollen and wood/charcoal record from c. fifth/sixth century AD (O Carroll 2012, 227). This, it is postulated, is most likely related to an increase in the economic reliance on certain wood types through more formal wood collection and management strategies that emerged during this time (ibid.).

1.6.5 Wood in medieval Ireland: historical and archaeological evidence

Despite the extensive resources now available depicting medieval life, society and economy in Ireland, wood, trees and woodland have largely remained peripheral in medieval historical studies (O'Sullivan 1994). Through the archaeological record however, the survival of wooden artefacts (Earwood 1991, 1993, Comey 2003, 2010) and house structures (Wallace 1982, O'Sullivan 1993, Halpin and O'Sullivan 2000) have provided invaluable information on the types of woods selected for construction and manufacture, in addition to understanding wood working techniques, carpentry and tool technology in ship building (McGrail 1993), bridges and other robust structures (Geaney 2014, Geaney 2016). As wood is perishable, the evidence for medieval wood-working is largely confined to sites with waterlogged deposits and so there is a bias towards crannógs (Earwood 1991, 2011, O'Sullivan 1998), some raths with waterlogged ditches (e.g. Baronstown, Roestown and Killickaweeny, Co. Meath) (Linnane 2007, O'Hara 2007, Walsh 2008) and medieval urban centres such as Dublin, Waterford and Cork (Walsh 1997, Cleary and Hurley 1997, Hurley et al. 1997, Reilly et al. 2014, Lyons 2015b).

From this evidence has emerged that people understood and appreciated the properties of various tree species: oak was durable but easily-cleft for heavy carpentry; hazel, willow and ash for building wattle structures; alder and ash for carving wooden vessels intended to hold liquids; and finely-grained species such as yew-wood and holly for carving or making high-status objects like gaming boards and decorated wooden buckets (O'Sullivan 1990, 1992, 1994, Earwood 1991, 2011). Notwithstanding this evidence, the scale of woodworking activity is most likely under-represented overall, as residual waste from craftworking or building is often not recorded or does not survive in context.

Medieval woodland, woodland resources and the role of wood as a primary commodity from an archaeological context is however still largely under-researched in Ireland for the medieval period, with the main publications to date based on a qualitative bias using the historical records (Le Fanu 1893, Forbes 1932, Neeson 1991, Slattery 2009, Everett 2014).

Woodland in medieval Ireland: the historical evidence

Of the approximate 61,965 townlands recognised in Ireland, c. 13,000 (21%) are named after trees - root words expressive of woods, forests and trees include *coil/coillte* (wood); *daire/daur* (oak); *coll* (hazel); *cuileann* (holly); *sail* (willow); *iúir/eo* (yew), *trom* (elder) and *beithe* (birch), the earliest written records of which date to the seventh century AD (Joyce 1883). In most cases, the woods that lent their name to places in Ireland have long gone, but through the unique toponymy of Irish place names, we gain a fascinating insight into the high regard in which people in medieval Ireland held the humble tree.

The medieval woodland presented in the historical records and early law-tracts is generally one of farmland interspersed with individual trees and small woods (Kelly 1976, 52, O'Sullivan 1994). Many woods would have been privately owned, but it is emphasised in these tracts that all law-abiding freemen enjoyed limited rights to private woods (ibid.). The author of a ninth century series of geographical triads regarded large woods as unusual in the Ireland of his day. He lists the three wildernesses of Ireland (*tri dithreib Eirenn*) as *Fid Mar hi Cuailngi* "the great wood in Cooley" (Co Louth), *Fid Deicsen hi Tuirtre* "the wood of Deicsiu in Tuirtre" (probably on the slopes of Slieve Gallion, Co Tyrone) and *Fid Moithre hi Connachtaib* "the wood of Moithre in Connacht". In addition to these three, there is a reference in another ninth century text to a great wood (*Fid Mar*) to the west of the Sperrin mountains (Meyer 1906a).

Explicit details on later medieval woodlands from the twelfth to the fourteenth centuries are also relatively few surviving only from scant liberties and manorial court rolls (J.T. Gilbert 1870, Sweetman 1875, Hartland 2008). Irish forests were governed under the Anglo-Norman legal system, which was based on the English structure during this time. Despite this, Irish forests differed in that there was emphasise on them as sources of venison and timber and as a means of giving gifts to high-ranking subjects rather than as locations for elite hunting (Beglane 2018, 91). While woodland and forests provided sources of food, timber, pasture and pannage, it was their value as a symbol of royal favour that overtook their calorific and economic importance (ibid.).

By the early sixteenth century, based on cartographic evidence at least, it has been postulated that just 1/8 of Ireland was classified as woodland, with the presence of ironworking being the primary evidence for the existence of these wooded regions (McCracken 1959, 273). At the time of Civil Survey of 1654-56 many of the townlands bearing the name of woods were relatively treeless where only wood for domestic use remained (ibid. 278). This source of information should be interpreted with caution however, as The Civil Survey provided a bias towards lands in Protestant hands, (approx. 60% by 1640), so many areas are under enumerated. It is therefore a highly unreliable source for natural resources. The subject of later medieval forests, albeit under royal control, is now only being addressed and reconstructed using an interdisciplinary approach, combining historical, cartographic and archaeological evidence (Beglane 2018).

Wood in early medieval literary sources

Traditionally, trees played a pivotal role both practically and spiritually in the lives of people in the past in Ireland (Lucas 1963, Kelly 1976), Britain (Rackham 1980b, Linnard 1982, Haycock 1990, Hooke 2010) and other cultures (Gupta 1980, Seeland 1997, Jones and Cloke 2002, Dafni 2006). Many early forms of literature using prose, sagas and poetry also provide details of the importance of tree lore in many traditions (Philpot 1897, Lang 1902, Randolph 1943, Ohlgren 1988). The role of woodlands in the Irish medieval social system can be observed through the Brehon Laws, the statutes which governed Gaelic life in medieval Ireland from the seventh to the seventeenth century AD (Kelly 1976, 1988, Binchy 1970). While the legal information pertaining to trees is limited and fragmented in these documents, the scholarly works of Lucas (1963), Binchy (1970) and Kelly (1976; 1988) have been instrumental in providing a solid foundation for continuing research on this subject.

The *Bretha Comaithchesca* (Law of the Neighbourhood) which dates from the eighth century AD and an earlier dated text *Fidbretha* ('tree-judgements'), provides the most informative details on woods and shrubs in early medieval Ireland (Binchy 1971, 1978, Kelly 1976, 1997, Ó Corráin 1983, Quinn 2011). These texts recognise a hierarchy among trees and classified them in accordance with their economic value, which was based on timber quality and fruit and fodder yield (Kelly, 1997, 380). These accounts also detail the penalties given for damage to trees and shrubs (Kelly 1976, 39). Four different degrees of damage are distinguished: complete extirpation of the tree, cutting it off at the base, fork-cutting and branch-cutting. Obviously, damage to an especially valuable tree such as an oak or yew would be a more serious offence than to a less prized tree such as a birch or willow (ibid.).

Trees were therefore classified on a hierarchical ranking, based on functionality (timber quality and fruit production), cultural significance and their status as boundary markers:

Airig Fedo (Nobles of the Wood): oak, hazel, holly, yew, ash, apple
Aithig Fedo (Commoners of the Wood): alder, willow, hawthorn, birch, elm, wild cherry
Fodla Fedo (Lower Divisions of the Wood): blackthorn, elder, juniper, spindle, whitebeam
Iosa Fedo (Bushes of the Wood): bracken, gorse, bramble, heather, wild rose

Oak and ash were both held in high esteem, which shows that they were somewhat equal in value. The value of oak is said to derive from 'its acorns and its woodwork' (*a mes; a saíre*) and ash due to its 'support of a royal thigh and…weapon' (*folach rígslíasta; letháraid airm*), suggesting its use in furniture and spear-shafts (ibid. 381; 383). There was also awareness that the presence of ash was a sign of good arable land (Kelly 1976, 42). The ninth century commentary attributes the yew's inclusion among the lords of the wood to 'its noble artefacts'. There is frequent mention of the use of yew wood in the manufacture of domestic vessels, and a law-text in the *Uraiceacht Becc* on status includes the *saí ibrorachta* ‘expert in yew-work’ as one of the categories of craftsman. In later legal commentary this tree is described as *int eochrann aicdide* ‘the yew-tree of artefacts’ (ibid.).

By the eleventh century, yew became the favoured wood species for stave built vessels in Ireland, including the hoops and bases (Comey 2003). Comey has postulated that it could be related to cultural selection and status, as it was often associated with royalty and as a symbol for wholesomeness (2003, 52-53). It is no surprise therefore that the wooden cores of ornate croziers dating from the ninth to the twelfth centuries are largely made of yew wood, implying that yew may have held some cultural significance in the manufacturing of these relics. Yew wood was used in the Kells crozier (McDermott 1955), St. Mel’s crozier (Oddy and McIntyre 1973) and it has also been surmised that a crozier from Inishmurray, Co. Sligo was also made of yew wood, although no formal identification of this artefact has been carried out to date (Bourke 1985). Similarly, holly was also afforded high status due to its hard wood for turning and for its use as a winter fodder for livestock (Kelly 1972, 43).

Blackthorn is referenced in early law tracts as the wood of choice in constructing a standard *nochtaile,* or ‘bare fence’, also referred to as a *felmae* or *felm* (Kelly, 1997, 374). This was constructed as a fence for keeping animals in or out; it consisted of four foot stakes set eight inches apart, with three pliabe rods (*trí bunchuir*) woven between the stakes. The stakes should project three fists above the wattling with a crest of blackthorn on top (ibid. 375) **(Figure 1.6.1).**

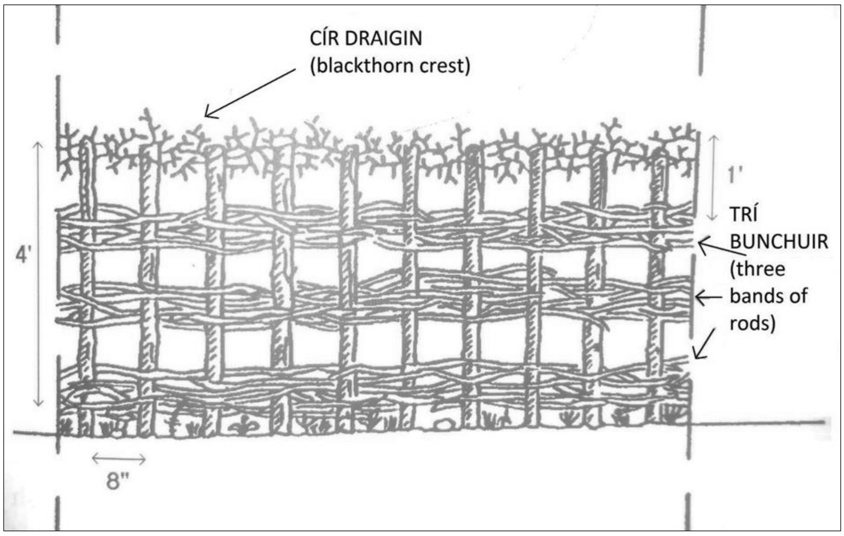


Figure 1.6.1 A suggested illustration of a *nochtaile* (bare fence) (after O'Kelly 1997, Fig. 19, 375)

Trees also abound in Irish folklore, a frequent theme being sacred trees or *bile*. Sacred trees were found at holy wells, churches were constructed at the site of sacred trees and groves and cultural ceremonies and royal inaugurations were often performed at a specific tree. The legal protection of these revered features was also documented in the eighth century poem, *Ma be rí rofesser,* from the law tract *Críth Gablach* which reads: "A danger from which there is no escape is the penalty for felling a sacred tree" (translation D. A. Binchy) (Binchy 1970). To destroy such trees would have therefore been an act imbued with wider religious and political connotations, and so their veneration suggests a deep-rooted sense of cultural identity and place.

Oak in the early historical sources

While woodland and wood use is often discussed in general terms, with few references to specific species, oak is probably the most frequently mentioned taxon in the early Irish literary sources, with particular emphasis on its functionality and importance as a food resource.

Fencing

While the formality of the early Irish laws that governed woodland represents the ideal rather than the day-to-day prosaic reality, there is recognition to implementing some degree of conservation when it comes to fencing. Specific details on the types of field boundaries or fences were documented in the laws giving explicit details about the measurements, style and materials that should be used (Binchy 1978 i 73.7-18; O'Corráín 1983, 247-251; Kelly 1997, 372). One such wooden fence was the oak fence (*dairimbe*), described as consisting of cut oak –trees laid horizontally so as to form a dense barrier specifically to protect woodland from damage by both small and fully grown animals (*damscuithit*) (Binchy 1978, iv 2133.22-6; O'Corráin 1983, 248; Kelly 1997, 376). This type of fence was to be durable and long-standing and not to be replaced by another type of fence construction (O'Corráin 1983, 250).

To ensure its permanency, any damage, resulted in some form of restitution, which varied according to the level of destruction (a yearling bullock for three stakes; a yearling heifer for five stakes; a two-year-old heifer for eight stakes and five sets [unit of currency] for twelve stakes) (Binchy 1978, i, 79.10-12; Kelly 1997, 378). Similarly, fines were also enforced for the cutting down of a noble tree (1/2 milch cow), cutting its branches (a year old heifer or *dairt*), fork cutting (a two-year old heifer or *colpthach*) or bare cutting (one milch cow) (Binchy 1978, i, 202.16-33; Kelly 1976, 109). Fines seemed to have taken into account the species not the size of the tree, with the highest penalties awarded for cutting or damage to oaks (Kelly 1988, 274; Kelly 1997, 387).

Food source

Palaeoclimatic proxies and palaeoenvironmental studies for Ireland suggest that, in general terms, the early medieval climate was warm and wet with a downturn occurring possibly after the late-eighth century (Kerr et al. 2009). Indeed the proxy climate record for this period shows variability and weather extremities in Ireland, Britain and other parts of Europe (e.g. Barber et al. 2000, Dark 2006, Dugmore et al. 2007, Swindles et al. 2010). The palaeohydrological data suggests that a date of c. 770 AD marks the end point of a 750-year long dry phase and the beginning of a wetter period that culminated in the Little Ice Age of the later medieval period (O'Sullivan et al. 2013, 328). Considering the number of annalistic accounts of tumultuous weather conditions, extreme climatic events were occurring every decade or so between the eighth and ninth century AD - *Annals of Ulster* (AU) (Hennessy and MacCarthy 1901); the *Annals of the Four Masters* (O'Donovan 2009); the *Chronicim Scotorum* (CS) (Hennessy 1866); the *Annals of Clonmacnoise* or

Macgeoghan's Book (Murphy and Mageoghagan 1993) Murphy, 1896); the *Annals of Tiernach* (Stokes 1897), the *Annals of Innisfallen* (MacAirt 1988) and the *Fragmentary Annals of Ireland* (Radner 1978).

Increased palaeoenvironmental proxy research is demonstrating that environmental change had a significant impact on influencing human activity in the landscape and in turn their settlement patterns (Turney et al. 2006, Kerr et al. 2009). Such environmental events would have created local social upheavals if there were food shortages or strained food production and distribution giving rise to economic instability and insecurity. In times of such crisis, where harvests failed, other foodstuffs, such as nuts were needed to compliment, supplement or replace grain-based products (Murphy 1956, 14 (poem 18)). It is well documented that nuts were stored as a winter food in the medieval period (Meyer and Wollner 1892, 306, Kelly 1997) and even ground down to form a kind of meal (*maothal*) (O'Curry 1873, 356-356). Similarly, acorns were often used as a food fodder for domesticated pigs during winter months (O'Keeffe 1931, 307, 381-303, Kelly 1997).

To understand further the importance of acorns in the medieval diet, it is worth considering the value of oak with regard to livestock during this time. The acorn crop ('oak-fruit' or *mess*) has frequent connotations to pigs in the early Irish sources (Binchy 1978 iv 20996.20-4; v 1121.32940-60; Kelly 1997, 83) and indeed there was a distinction between nut-crop for human consumption (*cnómess*) and acorn-crop for swine (*daurmess*) (Kelly 1997, 305). If the zooarchaeology record is considered, evidence from early medieval Ireland, recently re-appraised by McCormick and Murray (2007) and the EMAP project (McCormick et al. 2011) shows that evidence for pig on early medieval sites sees an increase from the seventh and eighth century AD, possibly highlighting a shift in animal husbandry at this time.

To emphasise the importance of oak woodland for wood-pasture or swine pasture in Anglo-Saxon England, there was an increase in the number of charters granting such lands from the eighth century AD (Hooke 2010, 144). The oak crop is harvested in September and October and served to fatten up young pigs for winter killing or provided them with fodder during the winter months (ibid.). The cycle of swine fattening on acorns followed by slaughter was so important within the medieval agricultural cycle that it became the standard calendar depiction for either October/November or November/December (Jørgensen 2013) **(Figure 1.6.2).**

Figure 1.6.2 St. Albans Psalter c.1140 historiated initial KL in October calendar showing a swineherd knocking down acorns for a pig (Copyright © Bodleian Library, University of Oxford, MS. Auct. D. 2. 6, fol. 6r.)

1.7 Conclusions

The use of charcoal to assess the nature and character of wood use during the medieval period is the only body of archaeological material that has not been coherently analysed. This chapter has provided a review of the past and current research that has been undertaken for the medieval period, yet wood use and woodland still remains a largely elusive subject, despite the archaeological and historical evidence available.

While this project alone cannot provide a full examination of medieval woodland and wood use, charcoal assemblages representing human activity during this period does need attention, so that a more comprehensive picture of wood resource use, management and changing woodland dynamics can be objectively discussed. To present the validity and strength of charcoal as a viable tool for interpreting archaeological wood in context, a critique of the current practices and methods will be presented in Chapter 2.

2 Charcoal Analysis: History, Methodologies and Critique

2.1 Introduction

Charcoal is the product of chemical reactions that occur when wood is heated (i.e. thermal decomposition) (Smart and Hoffman 1988, 172), an inert material that can survive many taphonomical and post-depositional conditions. It is probably the most ubiquitous environmental material found on archaeological sites yet often the most neglected. Aside from radiocarbon dating, it can yield fundamental information to further our understanding of vegetation patterns in the past, the relationship between people and this natural resource and the social, economic and cultural factors that play a part in how wood and woodland were viewed, exploited, managed and revered in the past. This chapter will discuss the current state of charcoal studies both in Ireland and abroad and evaluate its use as an interpretative tool for archaeological and palaeoecological interpretation. It will critically review the methodological approaches for optimum fragment count and quantification of archaeological charcoal assemblages to help establish what methods should be applied within the context of this thesis, particularly associated with medieval sites and individual features that typically define these site types.

2.2 History and background to charcoal analysis

One of the first major papers published on archaeological charcoal analysis was from Maiden Castle, Dorset, England, where charcoal was analysed from three Neolithic, Early Iron Age and Late Iron Age deposits (Salisbury and Jane 1940). Other than to suggest that wood was gathered close to the site little other inferences could be made to understand greater wood use or local woodland reconstruction (Salisbury and Jane 1940, 310) The results were subsequently questioned by Godwin and Tansley (1941) who highlighted the importance of considering taphonomic factors, ecological variables, wood selection and other cultural factors when interpreting charcoal remains from an archaeological context. (Godwin and Tansley 1941, 118). Subsequent works by Momot (1955) and Couvert (1969, 1976) also used the study of archaeological charcoal to help with recreating past environments in a prehistoric context. The introduction of reflected light microscopy in the late 1960's revolutionised the discipline allowing charcoal to simply be fractured by hand (Santa and Vernet 1968, Vernet 1973). This method was first used in an early study of Bronze Age charcoal from Jericho (Cecilia Western 1971).

Despite these works, the discipline suffered from a relative lack of any methodological framework. During the 1980's, the University of Montpellier and Valbonne in France became pioneers to lay the foundations for a systematic application of charcoal analysis on archaeological sites (Chabal 1988, Chabal 1992, Chabal et al. 1999). The identification and spatial analysis of archaeological charcoal have been used widely to make inferences regarding human wood use and forest ecology in the past (Chabal et al. 1999, Thiébault 2002, Asouti and Austin 2005, Dufraisse 2006). This research usually compares the proportions of woody taxa in archaeological charcoal assemblages to modern local woodland composition and then aims to interpret differences as the result of climatic or geomorphological change (Chabal 1992, Delhon 2007) or human induced landscape modification, including selective harvesting and widespread deforestation (Miller 1985, Willcox 1974, Willcox 2002).

Much of this work is based on the model of "Principle of Least Effort" which states that people in the past collected firewood from woodland closest to their settlement and that all species were collected in direct proportion to their occurrence in the surrounding environment (Chabal 1991, Shackleton and Prins 1992). Environmental circumstances and human decision-making processes however are complex systems and can render the principle of least effort more or less likely to apply to a given archaeological situation (Shackleton and Prins 1992). In an attempt to reconstruct past vegetation patterns, Chabal (1988) accepts that the material analysed (charcoal) is not the direct object of study (past woodland), but a compound picture of these source communities (Chabal 1992). Therefore, it is not methodologically viable to accept that a taxa present and their relative frequencies reflects directly the ecological background from which they derive. Such values can only infer palaeoenvironmental change over time in line with an appropriate theoretical application (Asouti and Austin 2005, 4).

2.3 Development of an emerging discipline

It is only in the last twenty years that charcoal studies are being incorporated into multi-disciplinary structures, with pollen, phytolith, soil and sometimes isotopic studies being executed concurrently (Delhon et al. 2003, Jashemski and Meyer 2002, Emery-Barbier and Thiébault 2005, Nelle et al. 2010, Wacnik et al. 2016). Pollen studies are particularly useful for comparison with wood charcoal results, especially if results can be obtained as closely as possible to the projected wood collection areas. Work by Nelle at al. (2010) in the Bavarian forest used such techniques to establish that both applications worked well reconstructing vegetation on a local level while some disparity was evident between regional pollen diagrams and the charcoal record (ibid.).

In a similar approach, O Carroll's research (2012) merging charcoal with local pollen profiles in an Irish context, deduces that proportions of wood taxa through charcoal was more closely related to the geographically closest pollen record, particularly during the prehistoric period. In a more nuanced approach, charcoal has been used as a tool in understanding periods of local woodland clearance for agricultural purposes (Robin et al. 2014) and other anthropognic signals, such as the effects of mining on local woodlands during the prehistoric period in Britain and Europe (Mighall and Chambers 1993, Kaal et al. 2013).

Much of the earlier work on archaeological charcoal assemblages is inclined to focus largely on environmental reconstruction using different methodological approaches (Salisbury and Jane 1940, Asouti 2003, Asouti and Austin 2005, Chabal 1992, Chabal et al. 1999) and less on the archaeological interpretation of the charcoal congruent with on-site activity. In recent years this has changed as charcoal sampling and quantification strategies are being refined and modified (Smart and Hoffman 1988, 176, Asouti and Austin 2005) to consider the complexities and intricacies of the cultural fabric that can define human behaviour. One such study undertaken by Veal (2009) used charcoal as a model to identify urban wood supply patterns for Pompeii during the Roman period and how the socio-economic position of the city influenced wood resource and management strategies. German research has substantially focussed on medieval sites and consumption of wood through charcoal for kilns (Ludemann 2003, Ludemann 2006, Ludemann 2002, Robin et al. 2013) the results of which were compared to historical sources for wood management (Ludemann 2006, Ludemann 2011). The regional and local patterns of wood change recorded were explained by local ecological conditions, something which was not documented in the historical accounts for wood use at the time (ibid.). More recently, charcoal analysis of medieval kiln deposits from Belgium showed that the fuel wood selected locally changed over time based on environmental changes that were occurring to woodland at the site find (Deforce et al. 2013). Increasingly, studies are showing how the use of charcoal can go beyond the reconstruction of palaeoenvironment and firewood collection strategies, to investigate questions of past landscape management and subsistence systems using the historical record (Wheeler 2011, Crew and Mighall 2013, Ntinou et al. 2013, Dotte-Sarout 2017).

In Ireland, O'Donnell (O'Donnell 2007, 2011, 2016) and O Carroll (2012) have carried out detailed analysis on charcoal from prehistoric sites charting wood use from a multitude of different site and feature types within a regional landscape. Their results highlight correlations between different wood species within domestic and funerary contexts and presented previously unknown evidence of wood selection for cremation processes in Bronze Age Ireland (O'Donnell 2011, 2016). This further enhances the importance of charcoal to explain local and regional wood variations, however subtle, and how this impacted on wood selection within sites located close to each other. These studies also pioneered new approaches to interpreting charcoal remains within a cultural framework, providing insights into human behaviour and the factors that influence wood selection in a prehistoric context.

In an attempt to estimate original wood diameter from charcoal fragments, few analysts have started to analyse and record the growth curvature of annual rings (O'Donovan et al. 2003, 21, Dillon 2006, Wheeler 2007a). In more recent studies by Ludemann (2003, 2006), Margurie and Hunot (2007) and Heiss and Oeggl (2008) methods to standardise this approach have been devised. Marguerie and Hunot (2007) have developed a manual standard classification for example (**Figure 2.1).** Charcoals are divided into four groups, which exhibit: Strongly curved rings; Moderately curved rings; Weakly curved rings (at this observation scale, the rings seem straight and the rays parallel); Indeterminate curvature (on fragments without minimal condition). This helps to identify which part of the tree was used. They caution that this method reveals trends only and is not a measurement of the diameter of the wood, but merely a characterization (Marguerie and Hunot 2007, 1421). Implementing this approach on charcoal assemblages from Neolithic and Iron Age sites in Brittany and Normandy they were able to distinguish two states of the forest environment, where tree cover remained dense during the Neolithic, but was degraded and varied during the Late Iron Age (ibid. 1431).

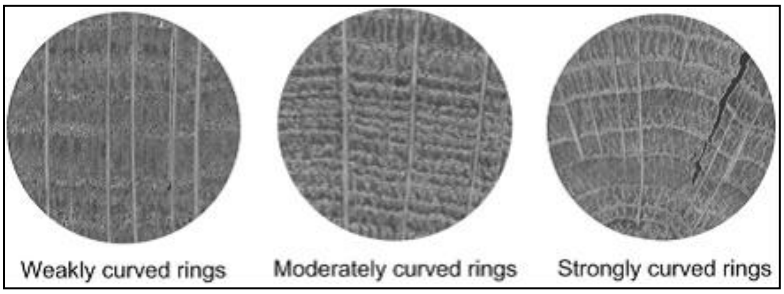


Figure 2.1 Ring curvature (Marguerie and Hunot 2007, 1421)

Conversely, Ludemann and Nelle developed their own method of charcoal measurement (Nelle 2002, Ludemann 2006) measuring curvature classes in centimetre groupings from medieval iron smelting charcoal remains in the Black Forest, Germany. For diameter determination charcoal fragments were sized by the curvature of the annual growth rings and by the angles of the rays to each other using a diameter template **(Figure 2.2).**

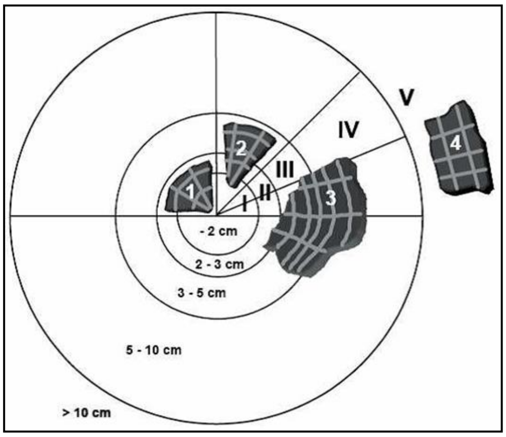


Figure 2.2 Ring diameter template devised by Ludemann (2006, 65)

This approach was also used on Neolithic assemblages from France (Lundström-Baudais 1986, Dufraisse 2002) and more recently from prehistoric sites in Flintbek, Northern Germany (Jansen et al. 2013), where two distinct groupings of wood were identified reflecting the temporal change in local woodland cover. It is clear from these studies that methods and standards are still developing however charcoal analysts are acknowledging the highly qualified results which ensue.

Digital measurements by Ludemann require specific equipment and are quite accurate, while the manual method (Marguerie and Hunot 2007) is more accessible but less accurate (Veal 2009, 93). Nevertheless, useful information can be gleaned about whether 'small', 'medium', or 'large' woods were used, if wood usage changed over time, and in broad terms how forests might have been managed. This application is still being standardised however but nonetheless will prove a useful tool for interpreting charcoal assemblages for woodland management in the form of coppicing, for example. Suitable fragment samples however will be dictated by preservation and fragmentation so caution is advised when applying it to certain charcoal assemblages.

It has become clear that the spectrum of charcoal research has moved forward to become an important component in understanding the changes and complexities of palaeoenvironmental and palaeoeconomical systems as well as fuelling new approaches through experimental research (Scott and Damblon 2010) **(Figure 2.3).** Through these studies however remains the inherent issue of methodological procedures relating to quantification for viable interpretation. These will be outlined and discussed later in this chapter.

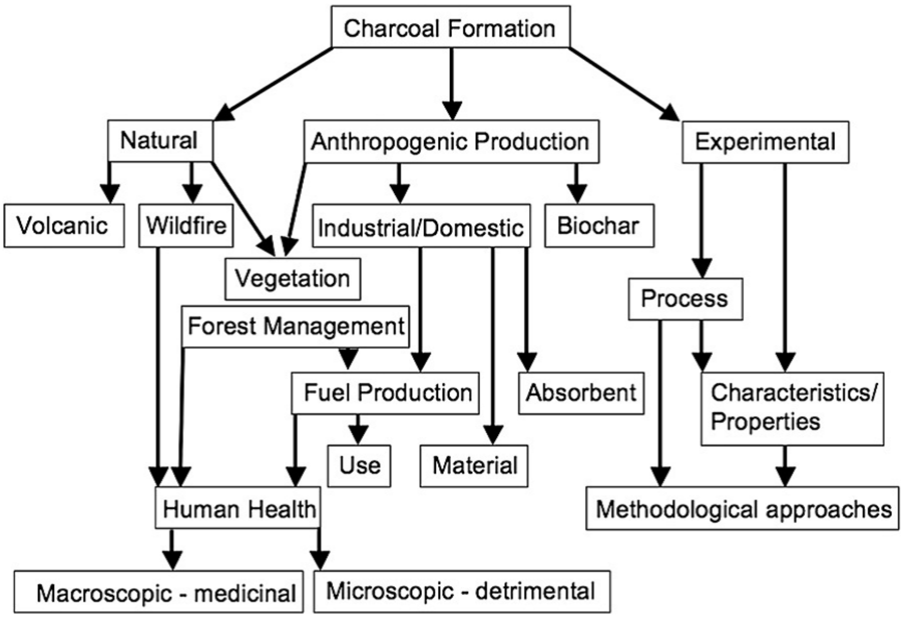


Figure 2.3.1 Diagram to illustrate the study and uses of charcoal and their inter-relationships (Scott and Damblon, 2010, Figure 1, p. 2)

2.4 Charcoal research in Ireland

Despite the pioneering research on archaeological wood remains through the *Mountdillion Bog Project 1985-1991* (Raftery 1996) and the *Lisheen Mines Archaeological Project* (Gowen et al. 2005), among others, the study of archaeological charcoal in Ireland is still very much an emerging discipline within the archaeological sciences. Through the work of O'Donnell (2011, 2016) and O Carroll (2012), methods for the sampling and quantification of charcoal assemblages have and are been formulated and standardised from both an archaeological and palaeoenvironmental perspective. Traditionally, charcoal identification was undertaken to identify a wood species prior to C14 dating (Waterbolk 1971, Stuijts 2006, 26, Haesaerts et al. 2010) and, occasionally, where budgets allowed it was used to provide a more detailed synopsis on local wood use at a site (O'Donovan et al. 2003, O'Donnell 2007).

Over the last 20 years, the increase in archaeological excavations, associated with national building programmes and pipeline projects has opened up large tracts of land exposing a vast array of archaeological sites, many of which were previously unknown. The Code of Practice designed by Ireland's national infrastructure and transport service, Transport Infrastructure Ireland (TII) in 2000 has provided a framework to protect archaeological heritage through best practice by establishing appropriate guidelines for archaeological excavation and sampling (Jameson and Eogan 2012, McClatchie et al. 2015b) This has facilitated more rigorous sampling strategies to be implemented for the recovery of environmental remains and other archaeological finds that generally go unnoticed during an excavation. As a result, there has been an exponential rise in the quantity of charcoal and other environmental remains being analysed and hence the information being collected. Despite this however, the majority of charcoal data remains unpublished and is still localised within the grey literature of site archives (Stuijts 2006, 26). These large assemblages representing a multitude of sites and features offer huge potential to further charcoal research in Ireland in facilitating both local and landscape studies.

The spectrum of published works on archaeological charcoal in an Irish context (O'Donovan et al. 2003, Van Rijn 2004, McKeown 2007, Newman et al. 2007, O'Donnell 2007, O'Donnell 2016, O Carroll and Mitchell 2011, 2012a, Cleary 2015, O'Donnell 2017) is low but increasing, which is testament to a discipline still in its infancy. For the most part, charcoal analysis has been undertaken on a site by site basis, which makes broader inferences and regional comparisons difficult to interpret. To help standardise methodologies to suit charcoal from Irish archaeological sites as a result of the upsurge in charcoal research, the *WODAN: Wood and Charcoal Database* was created (2008-2010).

WODAN is an online database developed to house biological and archaeological wood and charcoal data. The WODAN project (www.wodan.ie) was developed after various discussions with Irish archaeologists and wood anatomists working with archaeological wood and charcoal anatomists, who were looking to standardise the way in which wood and charcoal was sampled and recorded. The project was finded by the Heritage Council (grant references 16679, 16705 and AR01042) and brought together Irish and European wood and charcoal specialists, to discuss standards for charcoal recording (Stuijts et al. 2010, Stuijts and O'Donnell 2011). To date over 500 sites have been added to the database, which is designed to encourage and facilitate a range of research agendas, making Ireland one of the leaders in archaeological wood and charcoal research (Stuijts et al. 2010).

Just three landscape studies using charcoal analysis have been undertaken to explore wood use and woodland change in Ireland to date. One of the most extensive was a landscape-wide project along the Gas Pipeline to the West which created a chronological reconstruction of Bronze Age woodland and wood use (O'Donnell 2007). The results of this work revealed significant variations in wood use between geographically close sites of similar date. Expanding on this, O’Donnell’s research used charcoal analysis as a tool to interpret wood use and woodland change for Bronze Age settlement and funerary sites (O'Donnell 2011, O'Donnell 2016, O’Donnell 2017). Taking this one step further, the use of reflectance was tested, a novel approach to measure the temperature achieved by wood or wood charcoal when burnt, which allowed for a comparison between the use of domestic and industrial firing events, (O'Donnell 2011, Veal et al. 2011a, Veal et al. 2016).

Combining wood, charcoal and pollen, O Carroll’s research (2012) produced a chronological picture of woodland change and patterns of wood use for the Irish Midlands from the Neolithic to the post-medieval period. The results of this study has subsequently provided a framework for sampling guidelines on Irish archaeological sites, which is currently being implemented through the TII Code of Practice for archaeological excavation (O Carroll and Mitchell 2011, McClatchie et al. 2015b). To explore context-related variation using the charcoal record, *fulachta fiadh*/burnt mound sites are undoubtedly one of the most researched site-types in Ireland to date in the field of charcoal analysis and have proved to be a significant case study in this regard. These elusive features have offered new insights into prehistoric wood resource use, woodland management strategies, local woodland change and landscape use over time (O Carroll and Mitchell 2012b, Brown et al. 2016, Wheeler et al. 2016, Mighall et al. 2017). These projects have also successfully implemented statistics and GIS to highlight correlations between wood species on a spatial and temporal scale. Using these applications is a new approach to understanding environmental archaeological data in an Irish context and as a result is pioneering and promoting multidisciplinary agendas rivalling if not surpassing those being carried out elsewhere in Europe and beyond.

2.5 The sampling issue

Quantification methods concerning the number of charcoal fragments to be analysed from archaeological sites are still a contentious issue among charcoal analysts and no clear European standard has been reached (O Carroll 2012). Over the last few years, improvements in quantitative methodologies and standardised sampling procedures have been pioneered by studies in France (Chabal et al. 1999, Marguerie and Hunot 2007), the UK (Keepax 1988, Asouti and Hather 2001), Pompeii (Veal 2009) and Ireland (O'Donnell 2011, O Carroll and Mitchell 2011, O Carroll 2012).

The suitability of quantitative techniques undertaken from many sites seems to be based on the practical application of charcoal and its results (Asouti and Austin 2005, 5). Provided that the appropriate sampling, sub-sampling and analytical methods are considered for the settlement patterns, context of deposition and duration of activity (ibid. 14) palaeoenvironmental investigations using charcoal is becoming more viable. To address the issue of quantification, the processes that affect and influence the survival of charcoal remains in the archaeological record and the various methodological approaches used will be discussed and critiqued to establish best practice within the context of archaeological interpretation and the limitations that still exist.

2.5.1 Taphonomy and survival bias

In the broad archaeological sense, taphonomy is defined as the study of the series of processes an organism encounters after its death and until its discovery as a fossil (McRoberts 1998). These include natural deposition (Forbes et al. 2006), manufacturing processes (Babich et al. 2010) and other chemical, biological, or physical activity (McParland et al. 2007, Masiello 2004, Treusch et al. 2004) which can alter or affect the remains and how they survive. If applied to archaeological charcoal, this definition would limit taphonomy to the study of charcoal after the extinction of a fire (Théry-Parisot et al. 2010, 142). The picture however is more complex, as charcoal is the remains of survival bias, the result of both human and natural processes that are intrinsically linked and very often difficult to separate based on their effects (Théry-Parisot et al. 2010, 142). These processes are diverse and include; human practices for wood collection and hearth/kiln management;

settlement factors; climatic influences; the combustion process itself; depositional and post-depositional processes and analytical sampling and quantification **(Figure 2.5.1).**

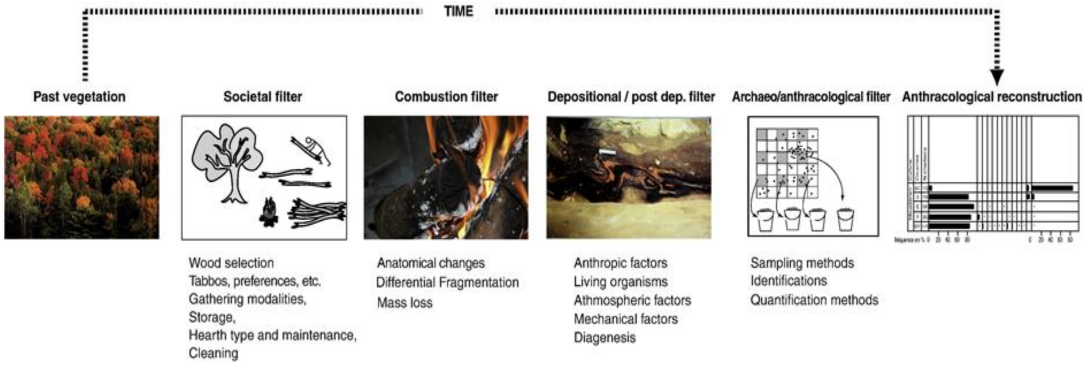


Figure 2.5.1 Successive agents of taphonomy from wood collection to charcoal analysis (Théry-Parisot et al. 2010, Figure 1, p. 143)

In an attempt to accurately use charcoal for palaeoenvironmental reconstruction, the agents intervening between the extant charcoal assemblages and the ways from which they were sourced must be removed. It must also be considered that various types of woods have different rates of burning, which is further exacerbated by the condition of the wood prior to being burnt – freshly cut, seasoned, deadwood, waterlogged, degraded or burnt as charcoal to begin with (Smart and Hoffman 1988). Consideration therefore of the non-linear interaction of a variety of natural and societal factors, constrained within a controlled analytical framework is paramount to understanding and charting a reliable course from the actual wood gathering process to the archaeological remains recovered and how they are interpreted (Théry-Parisot et al. 2010, 151).

2.5.2 Optimal fragment counts: Cumulative frequency

Charcoal samples can invariably differ in weight and contain an indeterminate number of fragments. In the case of very charcoal-rich samples, it is important to employ a suitable methodology to achieve the optimum number of fragments to analyse as a representation of taxa present (Keepax 1988, Asouti and Austin 2005). The size and number of charcoal samples analysed are important factors in establishing meaningful statistical results about sample composition (ibid.).

The universal method used to achieve optimum fragment count is known as cumulative frequency (saturation curve). A cumulative taxa graph (identification saturation curve) is a useful measure of sampling sufficiency with regard to possible discovery of all taxa in a context (Smart and Hoffman 1988, 176, Asouti and Austin 2005). This approach measures taxon diversity, the higher curve, the lower the diversity of wood taxa and vice versa. The number of fragments is plotted against the cumulative number of taxa identified. As the cumulative taxa count approaches its maximum, the graph, which commences typically with a steep gradient, will level off to a horizontal as the maximum number of taxa is approached (Smart and Hoffman 1988, 67, Keepax 1988, Chabal et al. 1999).

This practice was first examined in detail by the Chabal et al. (1999, 66) from the Montpellier School in France. They recommended that at least 250 fragments be identified per sample, with 400-500 fragments considered as the optimal sub-sample size per excavated level, based on their experience from west Mediterranean sites. It has been argued that this high frequency of counts is not a realistic approach for most of temperate Europe (Keepax 1988, Asouti and Hather 2001, O'Donnell 2011, O Carroll 2012).

Firstly, France has higher taxon diversity of tree species than that found in Britain (Keepax 1988) and Ireland (O'Donnell 2011). Secondly, this analysis describes an archaeological sample as a 'level' rather than a specific context, such as a pit or posthole. A collection of layers, features or contexts which refer to individual stratigraphical events, ultimately makes up an entire site (Keepax 1988, 50). For the most part, context variation is considered and a sample is defined as one fill or specific archaeological context (Keepax 1988; Asouti 2001, 96, 120; Wheeler 2011; O'Donnell 2011; O Carroll 2012), however Chabal et al. (1999, 66) describes a sample as representing a 'level', which is a layer or spread of charcoal associated with many features and formation processes. This clearly highlights the different approaches to archaeological excavation in different countries and may therefore contribute to the confusion of inferred methodological approaches.

Doctoral work carried out by Asouti (2002) on charcoal assemblages from Anatolia, Turkey concluded that 150-250 fragments per sample was a sufficient number. Using charcoal assemblages from British sites, Keepax (1988) established that identifying a minimum of 100 fragments was ideal to analyse from each sample, although depending on diversity of taxon present, 300-400 fragments may be required to be fully representative of the sample. A similar minimum was also used to analyse charcoal from medieval kilns in Bavaria, Germany (Nelle 2003, 185) while Wheeler (2011) used an average sample size of 50 charcoal fragments from medieval and early modern iron-working sites in Bilsdale, Yorkshire. Using cumulative saturation curves on material from Pompeii, Italy, Veal (2009, 72) deduced that an optimum number of 60-80 charcoal fragments be identified from each sample. This analysis however was for whole assemblages comprising samples from all features and time periods together, with no regard for the nature of individual samples or how they related spatially to each other.

In Ireland, 30-50 fragments per sample have been the minimum counts (Stuijts 2006, 28) especially on commercial archaeology projects which are largely influenced by time and budgetary constraints. With Irish charcoal studies on the increase (Van Rijn 2004, Stuijts 2007, McKeown 2007, O'Donnell 2007; 2011; 2015; 2016; 2017, Newman et al. 2007, O Carroll and Mitchell 2011, O Carroll 2012) work on devising suitable methodologies for Irish assemblages is a relatively new approach. Doctoral research by O’Donnell (2011) on Bronze Age charcoal assemblages was the first to challenge the British and European sampling methods as a model for interpreting exclusively Irish material.

Using cumulative frequency analysis her work concluded that a minimum of 80 fragments be the optimum number of counts analysed from a standard sample. While this work has designed a model of optimum sampling in an Irish context for Bronze Age sites, it cannot be taken as a standard sampling strategy for all archaeological site or feature types recorded from Ireland. In an attempt to develop recommended sampling protocols for charcoal analysis from linear landscape projects, O Carroll (2012) devised a model to establish the minimum number of samples to be analysed from specific site types spanning from the Neolithic to the Post Medieval period. Taking it one step further, the same model was used to obtain the optimal number of charcoal fragments that should be identified from each sample to obtain taxon presence and abundance.

A total of 50 charcoal fragments (where present) were identified from each sample used to determine optimal sample quantity per site while 100 fragments were identified for saturation curves to quantify fragment amounts per sample (O Carroll 2012, 100). From this, the optimum number of samples per site and fragments per sample varied from site to site, with the mean number of saturation points of taxon amounts being much lower than previous studies. For example, at least 25 charcoal fragments from at least six samples should be taken from *fulachta fiadh* sites; a minimum of 17 fragments from at least 24 samples from medieval occupations sites.

Through defining and constraining site types, this research has contributed to lower saturation points, which has offered a more robust method for charcoal sampling strategies in Ireland (O Carroll and Mitchell 2012, 279). While this study provides a standardised set of sampling guidelines for future archaeological investigations, it does so more broadly, without considering the variability of features/activities from each site type and their relationship to each other. It also accepts that sampling multi-period sites needs to be more refined and should be dealt with on a site by site basis (O Carroll 2012, 116).

A recurring theme throughout the previous cited studies however is that over-identification of individual samples does not compensate for identifying sufficient samples (Keepax 1988, 45). Recommendations vary from site to site and are subject to continuous debate (Miller 1985, Johannessen and Hastorf 1990, Thompson 1994, Asouti 2003, Veal 2009, O'Donnell 2011, O Carroll 2012). The variation in optimal sampling regimes between different zones is dictated by geographical location and climatic conditions, which ultimately influences tree diversity at a local and regional level. This aside, the nature of the site being studied, the variability of features within these study areas and indeed the method by which the site is sampled all play a significant part in sample selection, recording and ultimately analysis of charcoal remains.

2.5.3 Quantitative and qualitative approaches to interpreting taxon abundances

With optimum fragment counts now modelled or being remodelled, attention turns to how these counts can be quantified and qualified to allow for further analysis, especially when interpreting patterns of wood use and woodland reconstruction.

The traditional method used to quantify charcoal is by absolute counts (the raw number of each taxon in each sample). This takes on the assumption that this method accurately reflects the degree of human use (Hastorf and Popper 1988, 60). Using fragment counts only can create a bias and consideration must be given to what affects differential fragmentation of wood e.g. preservation characteristics of a tree and varying fire conditions (Smart and Hoffman 1988, 172-176). Recent studies have proven that quantifying charcoal remains exclusively in this way does not take into account factors such as preservation, taphonomy, sampling strategies nor the series of cultural and analytical filters that archaeological charcoal has endured (Chabal 1992, Chabal et al. 1999, Asouti and Austin 2005, Théry-Parisot et al. 2010, 143).

Implementing a quantitative approach has been criticised however due to the fragmentary state of charcoal and the differential responses of individual taxa to burning (Zalucha 1982). They question the basic validity of using charcoal fragmentation counts as an environmental indicator, given the rate of charcoal fragmentation and the various different influences which can bring charcoal to a site (human, cultural) (Zalucha 1982, Lopinot 1984, Rossen and Olson 1985, Smart and Hoffman 1988). To qualify this, some researchers proposed fragment weight rather than frequency as a measure of taxa abundance for interpreting wood use and woodland reconstruction (Willcox 1974, Miller 1985). The disparity that exists between the charcoal that has survived and interpreting these assemblages therefore depends on these parameters. To provide a methodological and theoretical framework for the application of charcoal analysis, workable models therefore needed to be established for viable interpretation.

Considering the filters (cultural, taphonomical, and analytical) that can obscure charcoal interpretation, Chabal instead used a percentage of fragment counts to create a model for palaeoenvironmental research (Chabal 1988, Chabal 1992, Chabal et al. 1999). In percentage frequency analysis (PFA), absolute counts are standardised, to account for difference in sample size or sample abundance and converted to percentages so that a more statistical measure of taxa present can be deduced (Scarry 1986, 214, Asouti and Hather 2001). Paramount to this approach, archaeological charcoal must meet the following criteria (Chabal 1988, Chabal 1997, Asouti and Austin 2005):

- Charcoal samples must originate from domestic fuel wood, or secondary sources (e.g. middens and ditch fills) which is most likely to contain an array of different type of wood taxa
- Charcoal must relate to long-term activities, such as:
    - Hetrogenous deposits (i.e kilns, fireplaces, hearths, structural deposits)
    - Synthetic deposits (i.e redeposited charcoal from good stratigraphical contexts representing a number of different sources)

Fundamental to this quantitative application is the “law of fragmentation”, which states that charcoal, irrespective of species, will fragment by producing a high number of small fragments and a low number of large fragments (Prior and Williams 1985, Chabal 1991, Shackleton and Prins 1992, 632) **(Figure 2.5.2).** Through this work, Chabal deduced that the mass of an archaeological charcoal assemblage will not differ whether the fragments are weighted or counted (Chabal 1997). If a suitable number of samples and fragments are analysed, the “law of fragmentation” should be applicable to charcoal results from every archaeological site. Thus, fragment counts and weights will correlate, allowing either method to be used (Chabal et al. 1999, Théry-Parisot et al. 2010). In addition, this approach also states that other parameters, such as the size of the wood, use of dead wood and fire temperatures are as if not more significant than cultural biases (Chabal 1992, 225).

Another method to qualify taxa abundance is ubiquity or presence/absence analysis (Willcox 1974, Hubbard 1980). This disregards the fragment count of a taxon, assuming they are too influenced by the degree of preservation to be meaningful, and looks instead at the number of samples the taxon appears within a group of samples. The taxon is considered present whether a sample contains one or multiple fragments of that species. The frequency score of a taxon is the number of samples in which the taxon is present expressed as a percentage of the total number of samples in a group (e.g. oak was recovered in 5 of the 10 samples, so expressed as 50%). In ubiquity analysis, the score of one taxon does not affect the score of another, allowing each score to be evaluated independently (cf.Hubbard 1980). By measuring the frequency of occurrence instead of abundance, it reduces but doesn't eliminate the effects of differences in preservation and sampling. This method is useful in highlighting general trends in large datasets or if little is known about sources of patterning affecting a particular dataset (Popper 1988, 64, Pearsall 2015, 214).

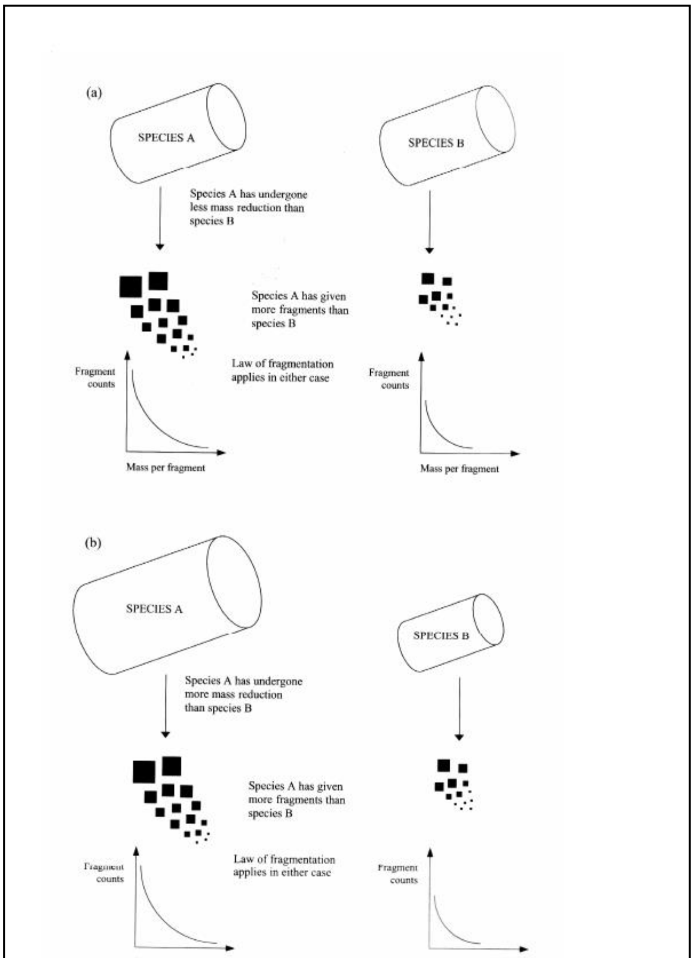


Figure 2.5.2 Law of fragmentation (Chabal 1992, p. 228-9)

Evaluating taxon presence is one method used to assess how representative wood charcoal is of past vegetation without depending on interference from anthropogenic factors (Asouti and Hather 2001, 26, Asouti 2002). Caution must be taken when interpreting groups of samples using this method as they can often obscure certain patterns in the data depending on how query building is devised (Hubbard 1980, 64). An even distribution of charcoal taxa is often noted across the site with little if any information on sample composition (Asouti and Austin 2005, 4). Results are also highly dependent on the group and number of samples and it provides no information as to the relative importance of different taxa at a site (Veal 2009, 90).

2.5.4 Quantification v Qualification

On reviewing the various quantification methods for analysing archaeological charcoal, attention now turns to how these methods have been used and to what effect, especially with reference to Ireland. The application of combining fragment counts, weights and presence/absence scores with respect to measuring taxa abundance seems to vary between different studies. Recent work charting wood use at sites in Tukey (Asouti, 2001), Pompeii (Veal 2009), Britain (Keepax 1988; Wheeler 2011) and Ireland (O'Donnell 2011; O Carroll 2012) are revealing that percentage frequency analysis (PFA) is the most effective method in quantifying archaeological-retrieved charcoal.

In contrast to ubiquity analysis, PFA values will change if the percentage of one or more taxon alters, so data are not independently represented. It was found to be a useful tool for reconstructing how intensively woodland catchments were being exploited and the long-term effects of human activities and potentially environmental change (Asouti and Hather 2001). This then considers context-related variation and permits a more holistic study of wood use patterns between different settlement phases and activities within the site itself (Veal 2009, Wheeler 2011, 18; 91; O'Donnell 2011, 182).

Ubiquity analysis proved useful in recording taxon present from prehistoric sites in Turkey (Asouti 2001) and medieval/early modern sites in Yorkshire (Wheeler 2011) where sampling was sporadic and varied across each site. These case studies have shown that ubiquity analysis and PFA measurements should be used in a complementary way and their final results evaluated in the light of the evidence provided by the off-site palaeo-vegetation record for woodland reconstruction (Asouti 2001, 115). While PFA was implemented in charcoal analysis from Pompeii (Veal 2009), ubiquity was not required since all taxa present were observed through the methodical sampling strategy employed at the site. Similarly, in Ireland using ubiquity analysis has proved ineffective, with taxon presence been easily detected via the large charcoal datasets that exist representing a cross-section of site types and features (O'Donnell 2011; O Carroll 2012). Instead, Irish analysts have tested the validity of the "law of fragmentation" as a means of quantifying charcoal fragments. This was to determine if PFA was indeed best practice for charcoal quantification or if fragment counts and weights were not mutually exclusive.

Results from a study of Bronze Age charcoal assemblages by O'Donnell (2011) revealed discrepancies between counts and weights, hence disagreeing with this approach and that charcoal interpretation should be based on a combination of both applications. This was also found to be the case from charcoal studies by Thompson (1994) in tropical areas, Asouti (2001), Wheeler (2011) and more recently Jansen et al. (2013). Interestingly, O Carroll's research (2012) showed a correlation between counts and weights, thus supporting this quantitative method.

One explanation for the conflicting views on using counts and/or weights could be the sub-sampling methods by which charcoal is selected for identification. When sub-sampling opts for larger fragments (>5mm) alone it runs the risk of naturally overlooking small-sized taxa (e.g., shrubs) or those procured mainly in the form of twigs and small branches, which are likely to be better represented in smaller size ranges. (Keepax 1988). This method of selecting fragments >5mm was largely employed by O'Donnell (2011) and Wheeler (2011). To accommodate the varied fragmentation rates of charcoal, resulting from temperature, burning rates and post depositional processes, O Carroll (2012) chose fragments <5mm.

Recent research by Chrzazvez et al. (2014) rigorously tested post-depositional processes on charcoal fragmentation and its effects on taxa representation. Results concluded that charcoal is very resistant to pressure and that while different taxa fragment in different ways, all species will still be represented in a larger fragmented state (>5mm). Therefore, limiting analysis to fragments >5mm will not induce less risk of under or over-representation of different taxa, with the exception of *Quercus,* which is over-represented in this class size (Chrazazvez et al. 2014, 39). While this experimental work does not take into account the fragmentation of charcoal by combustion, it does enhance our understanding of charcoal taphonomy by providing added resolution and improving the accuracy of charcoal analysis, which is particularly useful for quantification, selection and sub-sampling methods. It may therefore be the case that the "law of fragmentation" is determined by research objectives and available resources which will invariably influence different sub-sampling techniques.

2.6 Conclusions

While still a new discipline, the emergence of charcoal analysis as an interpretative tool for palaeoenvironmental and palaeoeconomical investigations has been subject to much debate. Over the last few years, improvements in quantitative methodologies and standardised sampling procedures have been pioneered by studies in France (Chabal 1992, Chabal et al. 1999, Marguerie and Hunot 2007, Théry-Parisot et al. 2010) the UK (Keepax 1988; Asouti 2001; Asouti and Austin 2005), Pompeii (Veal 2009) and now Ireland (Stuijts 2010 et al.; O'Donnell 2011; O Carroll 2012), strengthened by the creation of the WODAN Database (Stuijts et al. 2011). Crucial to these methods is the 'law of fragmentation', which has generally concluded that there is no difference in counting or weighting charcoal fragments and that either method can be applied to quantifying this material.

Experimental work to try and understand the effects of taphonomy and combustion on charcoal assemblages to help refine methodological procedures is on the increase (Théry-Parisot et al. 2010; Chrzazvez et al. 2014). New approaches to recording growth rings as a means of calculating wood diameter is underway (Ludemann and Nelle 2002; Marguerie and Hunot, 2007) and the development of reflectance, a technique which estimates the burn temperatures of charcoal (Braadbaart and Poole 2008, Veal et al. 2011b, Veal et al. 2016) is adding to the scope of this material in archaeological and palaeoecological research.

Despite this, the contentious issue of quantification and qualification remains under review. It is becoming apparent however as more and more studies are undertaken, that suitability of quantitative techniques from many studies seems to be based on the best practical application of charcoal for each site and its results (Asouti and Austin, 2005, 5). Provided that the appropriate sampling, sub-sampling and analytical methods are considered for settlement patterns, context of deposition and duration of activity, charcoal cannot be overlooked as a composite of palaeoecological studies and remains one of the few discipline that can profile the intimate yet complex and multifarious relationship between people and their local natural environment. Upon reviewing current quantification practices and procedures, Chapter 3 outlines the methodological steps that were used to achieve fragment and sample sufficiency for the charcoal datasets used in this thesis.

3 Methodology

3.1 Site selection

The charcoal data for this study has been sourced exclusively from 49 archaeological excavations carried out across two landscapes located in counties Tipperary and Kilkenny/Carlow. – The N8/M8 Cullahill to Cashel Road Bypass Improvement Scheme and the ecclesiastical site at Toureen, Peckaun were located in County Tipperary and the N9/N10 Kilcullen to Waterford Road Scheme; Phase 2 (Dunkitt to Sheepstown) and Phase 4 (Knocktopher to Powerstown) in County Kilkenny/Carlow **(Appendix 1).** Excavations undertaken within these linear transects facilitated the archaeological investigation of recorded sites as well as revealing a large number of previously unknown sub-surface archaeological activity. During the early medieval period both secular and ecclesiastical settlement began to take on a more concentrated form, as evident from the widely attested number of ringforts, enclosures and field systems recorded dating to this period.

While both schemes comprise a series of artificial geographical units, many of the sites can be placed within a known archaeological/historical and geographical context. The plethora of ringforts recorded in the region of Cashel town and to the north towards Twomileborris points to a vibrant early medieval landscape within the pre-Norman territories of the *Eogánacht Caisil* and *Eile Deiscert*, much of which had been previously unexcavated. Despite previous investigations, little in the way of pre-thirteenth/fourteenth century activity is known, equally compounded by the lack of publication. The archaeological evidence for later thirteenth/fourteenth century Anglo-Norman activity is also well attested in this area, which lies within the medieval earldom of Ormond, the medieval manor of Burgaslethe (Borris) and within the economic zone of influence of Cashel town.

The number of early medieval sites excavated in county Kilkenny is equally scant, with only three out of a recorded 1200 ringforts studied prior to the N9/N10 scheme (O'Sullivan and Harney 2008). In addition to raths, there are over 200 early ecclesiastical sites in Kilkenny, comprising a ratio of 1:6, a further index of widespread settlement in this region at this time (Manning 1990). Kilkenny shares a similar early medieval history to that in Tipperary, where territory was largely under the rule of the Osraige, which formed part of the Eogánacht dynasty of Munster for a time during this period. This landscape also succumbed to the Anglo-Norman regime in the thirteenth century, with Kilkenny City at its centre. Both counties became staunchly Anglo-Norman from the fourteenth century, with the Butler families dominating lands in Tipperary and Kilkenny at this time (Smyth 1990, 137). The continuity of archaeological activity from the earliest part of the medieval period through to the later medieval period within both areas, coupled with the influence of an urban stronghold in Cashel town and Kilkenny city from the early medieval period is the basis for selecting these study areas.

3.2 Sources of archaeological and palaeoenvironmental information

The main source of information used to facilitate this thesis were the final excavation reports for the N8/M8 Cullahill to Cashel Bypass Road Improvement Scheme in Co. Tipperary; Toureen Peckaun, Co. Tipperary and the N9/N10 Kilcullen to Waterford Road Scheme; Phase 2 (Dunkitt to Sheepstown) and Phase 4 (Knocktopher to Powerstown) in County Kilkenny **(see Appendix 1).** Excavation reports are the primary repository for all context, sample and dating information used in this research. In addition, a desk based study of all other known archaeological recorded sites and palaeoenvironmental investigations within these catchment areas was undertaken.

The sources for this information were obtained from the Record of Monument and Places (RMP www.archaeology.ie), Department of the Environment Heritage and Local Government (DoEHLG) archives, the National Museum of Ireland topographical files, the county Development plans, cartographic sources of the surrounding hinterland and various literature resources including published excavation summaries. The excavations as part of this study were undertaken by three archaeological consultancies which included *Judith Carroll/Network Archaeology* (JCNA), *Irish Archaeological Consultancy Ltd* (IAC Ltd.) and *Valerie J. Keeley Ltd* (VJK Ltd) and in the case of the research excavation at Toureen Peckaun, Co. Tipperary, by Dr. Tomás Ó'Carragáin from the Department of Archaeology, University College Cork. Furthermore there were a number of unpublished excavation reports which include environmental specialist reports, and this grey literature was also consulted.

3.3 Sample selection

To address the research questions outlined in Chapter 1 **(Section 1.4)** the samples selected represented the variety of different activities typically found on rural medieval settlement sites. As a result of the linear excavation process, many sites were transected but few were fully resolved, resulting in a partial or localised glimpse of the archaeological activity that existed. To consider the cognisance of the source of the charcoal including context deposition as well as the types of activity associated with the wood use, attention was given to the features that defined settlement, occupation and industrial activity. These in some cases were identified and interpreted within the context of a defined site, while others represented areas or isolated features of peripheral activity associated with either known or unknown archaeological sites.

A series of sampling guidelines in line with the standard now in use for archaeological excavation works in Ireland (McClatchie et al. 2015) were proposed for features typically found to represent settlement, occupation and industrial activity. This approach also ensured that features representing both short term (postholes, single fill contexts) and long term deposits (e.g. ditches) were analysed to allow for a profile of wood use over time to be critically scrutinised. The following features were therefore selected:

Structural deposits

- All posts burnt *in situ* (100% sample)
- Selection of postholes without in situ burnt remains (100% sample)
- Selection of samples from slot trenches (sub-sample)
- Floor deposits (sub-sample)

Occupational/Industrial activity

- Hearths (100% sample)

- Corn drying kiln fills (100% and sub-sample depending on volume of deposit; where possible fire-pit, flue and chamber should be represented)
- Metalworking pits and charcoal production pits (sub-sample)
- Souterrain deposits (sub-sample)
- Any occupation deposits (sub- sample)
- Ditch features (sub-sample each fill where possible)
- Pits containing *in-situ* burning and unclassified pit features (sub-sample each fill where possible)
- Burnt spreads (sub-sample)

A total of 664 samples representing 518 features were selected for this study **(Appendix 2).** These were primarily from the diverse range of features typically recorded on medieval secular and ecclesiastical settlement, as well as isolated features pertaining to known or unknown medieval archaeological activity. These features included structural deposits (postholes, stakeholes, slot trenches), enclosure ditches and linear ditches, a souterrain, industrial/production activity (corn drying kilns, metalworking pits/furnaces and charcoal production pits), hearths and unclassified pits (*in situ* scorching and no scorching). In total, 20,953 charcoal fragments were identified from these samples **(Table 3.2).**

Table 3.2 Number of samples and charcoal identifications per site

County	Site name	Site type	No. of samples analysed	Charcoal counts
Tipperary	Ballydavid AR26	Industrial: Corn drying kiln	6	214
Tipperary	Moycarkey Site 12	Occupation	1	70
Tipperary	Moycarkey Site 13	Pits	2	115
Tipperary	Moycarkey Site 15	Iron working	2	115
Tipperary	Borris AR33	Enclosed Settlement	27	1058
Tipperary	Borris & Blackcastle AR31	Industrial: Kiln/Metal/Mill	17	974
Tipperary	Gortmakellis AR1	Enclosed settlement	20	451
Tipperary	Monadreela Site 5	Industrial: Corn drying kiln	1	100
Tipperary	Monadreela Site 8	Enclosed settlement	13	322
Tipperary	Monadreela Site 9	Enclosed settlement	13	461
Tipperary	Monadreela Site 11	Enclosed settlement	35	598
Tipperary	Monadreela Site 12	Enclosed settlement	3	139
Tipperary	Boscabell Site 19	Enclosed Settlement	12	354
Tipperary	Boscabell Site 20	Enclosed Settlement	15	613
Tipperary	Hughes-Lot East Site 25ii	Enclosed settlement	139	2826
Tipperary	Hughes-Lot East Site 25iii	Enclosed settlement	2	69
Tipperary	Hughes-Lot East Site 25iv	Enclosed settlement	19	521
Tipperary	Farranamanagh Site 40	Industrial: Metal/furnace	27	582
Tipperary	Windmill Site 35	Pits	8	223
Tipperary	Toureen Peckaun	Monastic settlement	58	2540
Kilkenny	Baysrath AR53/54	Settlement complex/cemetery	6	299
Kilkenny	Tinvaun Site 3	Pits	16	515
Kilkenny	Knockadrina Site 2	Enclosed settlement	33	1181
Kilkenny	Kellysgrange Site 3	Industrial: Corn drying kiln	18	689
Kilkenny	Holdenstown Site 1	Enclosed settlement	9	393
Kilkenny	Holdenstown Site 2	Cemetery settlement	17	461
Kilkenny	Danesfort Site 5	Pits	7	139
Kilkenny	Danesfort Site 6	Occupation	10	380
Kilkenny	Kilree Site 3	Cemetery settlement	47	809
Kilkenny	Kilree Site 4	Enclosed settlement	17	679
Kilkenny	Templemartin Site 1	Industrial: Corn drying kiln	2	100
Kilkenny	Kellysmount	Pits	2	50
Kilkenny	Milltown Site 3-5	Industrial: Kiln/metal	16	789
Kilkenny	Ballykeoghan	Industrial: Corn drying kiln	4	103
Kilkenny	Jordanstown	Pits	3	124
Kilkenny	Scart	Industrial: Corn drying kiln	1	248
Kilkenny	Shankill Site 2	Industrial: Corn drying kiln	2	75
Kilkenny	Shankill Site 5	Pits	2	100
Kilkenny	Leggetsrath East	Occupation	7	249
Kilkenny	Scart & Rahard	Industrial: Corn drying kiln	1	50
Kilkenny	Coolmore	Industrial: Corn drying kiln	3	310
Kilkenny	Earlsrath Site 32	Ditch	4	166
Kilkenny	Earlsrath Site 33	Ditch	2	57
Kilkenny	Earlsrath & Ballylusky	Metal working	1	50
Kilkenny	Rahard West	Occupation	2	200
Kilkenny	Riceland	Ditch	1	52
Carlow	Moanduff Site 1	Pits	3	144
Carlow	Moanduff Site 2	Industrial: Kiln/furnace	3	129
Carlow	Coneykeare Site 1	Enclosed Settlement	5	50
TOTAL	**49 Sites**		**664 samples**	**20,953 fragments**

3.4 Sampling methods

Sampling is the strategy of selecting a smaller section of the population that will accurately represent the patterns of the broader population (Orton 2000). In this study a sample is classified as one fill or specific archaeological context as is the normal methodological procedure on archaeological sites. In Ireland it is common practice to take bulk soil samples from defined and undefined features to accommodate a range of environmental investigations. This inhibits any bias when selecting larger individual macro remains (large charcoal fragments or nutshell) and allows for smaller archaeobotanical remains (small charcoal fragments, cereal grain etc.) to be identified and analysed (Stuijts 2006, 27). The budgetary and time constraints of commercial archaeology however make it unfeasible to sample or indeed analyse every context excavated. As a consequence, to facilitate a programme of robust soil sampling within the commercial sector, the *Institute of Archaeologists of Ireland* (IAI) and the *Transport Infrastructure Ireland* (TII) have devised practical sampling guidelines for field archaeologists.

In the case of the TII sampling guidelines, (McClatchie et al. 2015), palaeoenvironmental services now form part of the method statements in the context of a managed process within the framework of a standardised contract for the provision of archaeological services. Taking into account the research aims for each individual site, these guidelines enable the provision of a systematic and focused approach that maximises the potential of data recovered from each site, allowing for consistent comparison of data within and between sites all within a standardised framework. They also allow sampling protocols to be assessed and reviewed during the course of the excavation without compromising best practice procedures.

The general soil sampling methods employed for the recovery of archaeobotanical remains are:

- systematic (samples are taken according to a clear strategy)
- judgement (focuses on deposits that appear to be potentially rich and informative)
- random (contexts selected in a statistically random manner)

- scatter (suitable for larger deposits where environmental remains may not be homogenously distributed).

Using a combination of primary sampling methods (systematic; random) together with a secondary sampling approach (judgement; scatter), ensures that an unbiased representation of environmental data is retrieved for objective analytical interpretation (McClatchie et al. 2015). In the case of guidelines for charcoal sampling, the methods employed are underpinned by O Carroll’s statistical analyses for optimum sample sufficiency (2012; O Carroll and Mitchell 2012); for example a minimum of 25 charcoal fragments from at least six samples should be analysed from industrial sites; a minimum of 17 charcoal fragments should be analysed from at least 24 samples associated with occupation sites and fragment counts are required to achieve taxon proportion estimates with margins of error below 2.5% (O Carroll and Mitchell 2012, 275-9).

3.5 Sample processing

Post-excavation works involved the processing of soil samples using a system of flotation for the extraction of charcoal remains. Soil samples ranged in size from 0.1 litres to 50 litres averaging 5 to 10 litres in volume per sample. A mechanical flotation or Siraf tank using a pump and water recycling system was used in the flotation of each sample. The sample was soaked in water and agitated by hand to loosen any charred remains from the soil particles which allows for this material to be separated and float to the surface. This floating material (flot) was poured off and trapped in a sieve (mesh size 250 µm) and, once dried, scanned for plant remains using a binocular microscope. The larger residual material left behind (retent) was washed through a 1mm mesh and air-dried.

A system of ‘grab sampling’ charcoal fragments was adopted when selecting charcoal for identification. This is the general method used by charcoal specialists in Ireland, where a variety of different fragment sizes are randomly selected for identification (Smart and Hoffman 1988). This ensures that both larger tree species (e.g. oak and ash) and smaller scrub species (e.g. birch, spindle, Maloideae species) are represented (Asouti 2001). This approach considers the varied fragmentation rates of charcoal which can be as a result of many factors including temperature, burning rates and post depositional processes, as discussd in Chapter 2. On reviewing the current procedures for size of fragments for analysis, a random mix of both <5mm and >5mm were selected from all samples. This would provide a controlled sampling regime to test the "law of fragmentation" for quantification and ensure that a robust representation of all taxa was achieved.

3.6 Methodology for sample sufficiency and quantification

To present and discuss the results of this thesis more vigorously, it was necessary to establish the best method of sample sufficiency for the main features that defined this study **(Section 3.3).** This was achieved by using saturation curve analysis. A representative number of saturation curves are used in this chapter to illustrate these results.

3.6.1 Saturation Curves

The main objective for using saturation curves as part of this study is to assess the adequacy and objectivity of the charcoal sampling strategy for each set of archaeological features to allow for an interrogation of the data for context-related activity and inter-site comparison. As discussed in Chapter 2 **(Section 2.5.2.),** the optimum number of samples per site and fragments per sample varies from site to site and feature to feature, where the nature of the site being studied and the variability of features within these study areas greatly influence sample selection and recording.

This test will not only build on the existing methodologies for sampling Irish archaeological sites (O'Donnell 2011, O Carroll and Mitchell 2012a) but will strengthen charcoal sample sufficiency for discreet features and defined activities associated with medieval dated occupation specifically. As previously outlined **(Section 2.5.2)**, it has become apparent that the optimum number of charcoal fragments for analysis from Irish archaeological sites is very much influenced by the type of context/activity being studied. The variability that exists ranges from a maximum of 80 fragments per sample to a minimum of 17 fragments per sample (ibid., McClatchie et al. 2015). To establish the best method of sample sufficiency for this thesis a number of saturation curves were plotted and analysed to assess taxa richness, diversity and distribution for each sample.

Due to the variety of archaeological features identified from the excavated sites within this study it was necessary to categorise features into discrete groups to complete the analysis. Consideration was given to known features excavated as part of a whole site and those excavated in isolation. Selecting features from different parts of a site is a significant aspect of the exercise, since the levelling off of saturation curves is not just a function of the number of examined fragments but also depends on the spatial extent of the sample population across the excavated area (Garcia 1992).

Of the 664 charcoal samples analysed as part of this study, a total of 151 samples (8641 charcoal counts) from 91 medieval features were selected as a subset for saturation curve analysis. The features selected represents those typically found associated with rural medieval occupation and industry – structural remains, enclosure ditches, corn drying kilns, metalworking features (pits and furnaces), hearths and unclassified pits **(Table 3.6.1; Figure 3.6.1).** Each sample selected also represents one context or fill within the features.

Table 3.6.1 Features selected to complete cumulative saturation curves

Feature type	Total features in study	No. of features analysed	No. of samples	No. of charcoal fragments	% of total analysed
Corn drying kiln	51	14	65	1782	27%
Ditch deposits	101	14	14	1400	13%
Posthole/Stakehole	133	29	29	1459	21%
Unclassified Pit	153	20	20	2000	13%
Metalworking	26	9	9	900	36%
Hearth	24	12	14	1100	50%

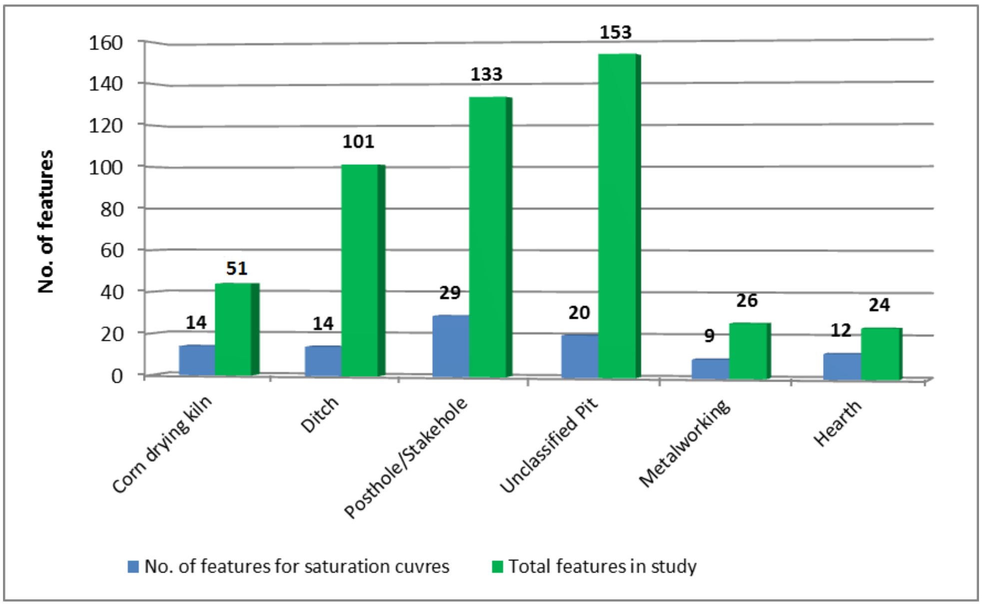


Figure 3.6.1 Sub-sample of features used for constructing cumulative frequency curves

To address the aim of how many samples and charcoal fragments to analyse, a sub-sample of the typical features excavated were selected for sample and fragment count sufficiency by plotting them onto a saturation curve - corn drying kilns; posthole/stakeholes; ditches; unclassified pits; metalworking/charcoal production pits and hearths - all features representing both short and long term deposits. The samples selected from corn drying kilns, ditches, pits and hearths contained a minimum of 100 fragments, the optimum number of charcoal fragments for species representation as per methods devised by Keepax (1988) and in line with charcoal research for Irish charcoal assemblages (O'Donnell 2011, O Carroll and Mitchell 2011).

In comparison, the quantity of charcoal from postholes was much lower, averaging 10 to 50 charcoal identifications in most cases a product of the low sample volume from these features overall. Postholes containing a maximum of 50 charcoal fragments were therefore selected for fragment sufficiency analysis. The exact occurrence (i.e. fragment number) of every new taxon identified during the analysis was recorded to help construct each relevant cumulative saturation curve. Cumulative saturation curves were constructed by adding successive samples or charcoal fragments cumulatively to determine whether the information provided by new samples or fragments is unique or redundant compared to information provided by earlier samples (Lyman and Ames 2007). When no new information is obtained by the addition of more samples or fragments (i.e. taxon) the curve levels off and is said to be saturated.

Saturation curves for corn drying kilns

Sixty five samples from 14 corn drying kilns were analysed for sample and fragment sufficiency **(Table 3.6.2)** by plotting the taxa diversity against the number of charcoal fragments identified from each sample. The total fragment counts analysed for this test was 1782. The average saturation point value for corn drying kilns was 48, which reveals that at least 48 charcoal fragments should be identified from samples associated with medieval corn drying kilns for meaningful quantitative analysis.

Table 3.6.2 Cumulative saturation values for optimal sampling amounts for corn drying kiln showing overall mean (ME± standard error) saturation point value

Site	Feature type	Context no.	No. of samples	No. of fragments	Saturation point
Gortmakellis	Kiln	C19	5	121	61
Borris/Blackcastle AR31	Kiln	C91	3	122	35
Borris/Blackcastle AR31	Kiln	C1758	6	143	64
Borris AR33	Kiln	C1145	5	133	47
Borris AR33	Kiln	C920	5	103	53
Monadreela Site 5	Kiln	C155	2	100	13
Monadreela Site 11	Kiln	C38	5	100	49
Hughes' Lot East Site 25ii	Kiln	C308	6	150	40
Hughes' Lot East Site 25ii	Kiln	C401	4	148	47
Hughes' Lot East Site 25ii	Kiln	C793	6	122	68
Hughes' Lot East Site 25iv	Kiln	C148	5	107	57
Hughes' Lot East Site 25iv	Kiln	C150	3	161	44
Kellsygrange Site 3	Kiln	C4	7	152	63
Holdenstown Site 1	Kiln	C159	3	120	27
Mean saturation point from corn drying kiln features analysed			**65**	**1782**	**ME 47.78 (±3.89)**

Figure 3.6.2 and **Figure 3.6.3** below illustrates the results of the saturation curves from an early medieval corn drying kiln [4] sampled from Kellysgrange, Co. Kilkenny and a late medieval kiln [91] at Borris/Blackcastle (AR31).

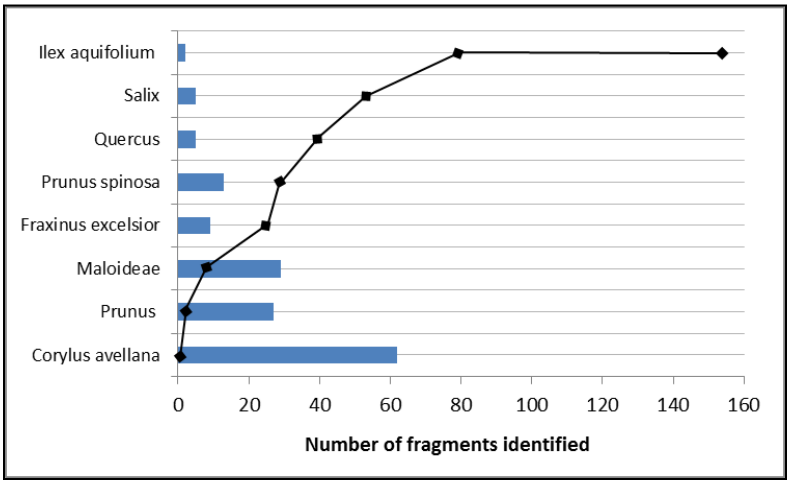


Figure 3.6.2 Saturation curve from kiln C4, Kellysgrange 3 AR073 Co. Kilkenny (152 fragments identified *Ilex aquifolium* identified at 78)

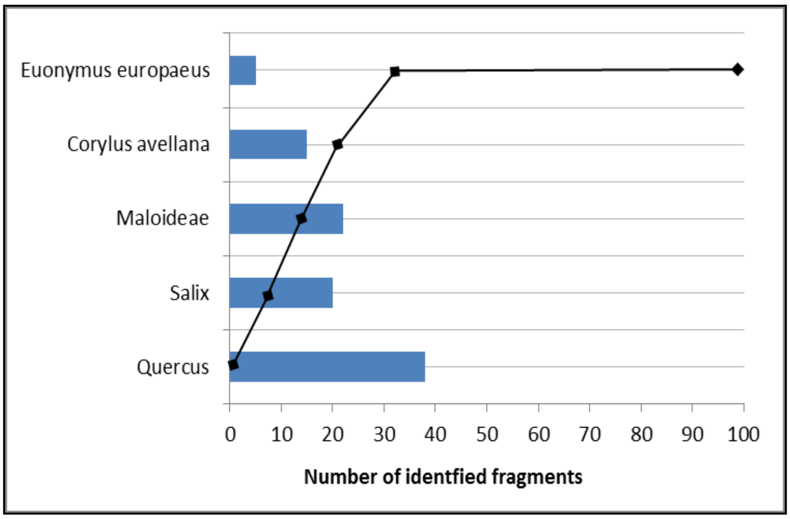


Figure 3.6.3 Saturation curve from kiln C91 Borris and Blackcastle, Co. Tipperary (100 fragments identified, *Euonymus europaeus* identified at 33)

Saturation curves for enclosure ditches

Fourteen samples from 14 enclosure ditches were analysed for sample and fragment sufficiency by plotting the taxa diversity against the number of charcoal fragments identified from each sample **(Table 3.6.3).** The total fragment counts analysed for this test was 1400. The average saturation point for ditch features is 40, which reveals that a minimum of 40 charcoal fragments should be identified from medieval ditches for meaningful quantitative analysis. **Figure 3.6.4** below illustrates the results of the saturation curves from an early medieval enclosure ditch [4] sampled from Hughes' Lot East (Site 25ii).

Table 3.6.3 Cumulative saturation values for optimal sampling amounts for ditches showing overall mean (ME± standard error) saturation point value

Site	Feature type	Context	No. of samples	No. of fragments	Saturation point
Hughes' Lot East Site 25ii	Ditch	C4/C568	1	100	48
Hughes' Lot East Site 25ii	Ditch	C3/C534	1	100	40
Hughes' Lot East Site 25ii	Ditch	C141/C426	1	100	50
Hughes' Lot East Site 25ii	Ditch	C3/C344	1	100	40
Hughes' Lot East Site 25ii	Ditch	C35/C320	1	100	33
Hughes' Lot East Site 25iii	Ditch	C29/C257	1	100	22
Boscabell Site 19	Ditch	C4/C194	1	100	43
Monadreela Site 9	Ditch	C108/C258	1	100	37
Monadreela Site 9	Ditch	C198/C116	1	100	34
Monadreela Site 9	Ditch	C112/C58	1	100	28
Borris AR33	Ditch	C5/C193	1	100	58
Borris AR33	Ditch	C1554/C1632	1	100	18
Borris/Blackcastle AR31	Ditch	C2132/C2133	1	100	51
Borris/Blackcastle AR31	Ditch	C1440/C1441	1	100	60
Mean saturation point from ditch fills analysed			**14**	**1400**	**ME 40.14 (±3.24)**

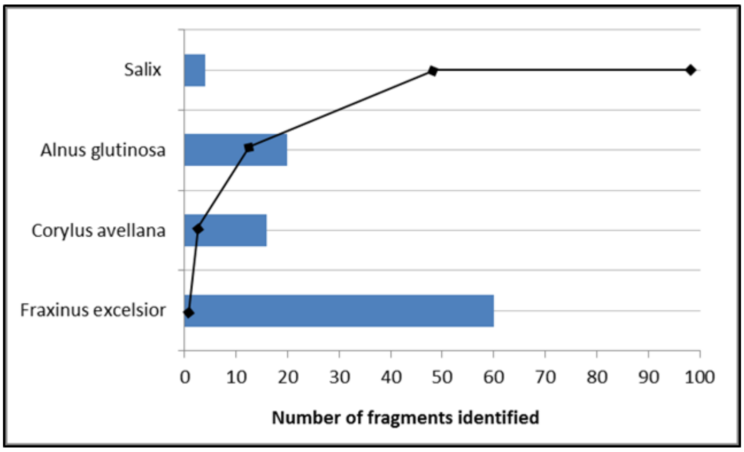


Figure 3.6.4 Saturation curve from ditch [4], Hughes' Lot East Site 25ii, Co. Tipperary (100 fragments identified *Salix* sp. identified at 48)

Saturation curves for unclassified pit features

Twenty samples from 20 unclassified pit features were analysed for sample and fragment sufficiency by plotting the taxa diversity against the number of charcoal fragments identified from each sample **(Table 3.6.4).** The average saturation point for unclassified pit features is 39, or that a minimum of 39 charcoal fragments should be identified from medieval pits for meaningful quantitative analysis. **Figure 3.6.5** illustrates the results of the saturation curves from a late medieval dated pit [1248] at Borris (AR31), Co. Tipperary.

Table 3.6.4 Cumulative saturation values for optimal sampling amounts for unclassified pits showing overall mean (ME± standard error) saturation point value

Site	Feature type	Context no.	No. of samples	No. of fragments	Saturation point
Borris/Blackcastle AR31	Pit	C308	1	100	55
Borris AR33	Pit	C2074	1	100	66
Borris AR33	Pit	C2023	1	100	1
Borris AR33	Pit	C1248	1	100	49
Monadreela Site 9	Pit	C246	1	100	34
Boscabell Site 19	Pit	C78	1	100	62
Boscabell Site 20	Pit	C49	1	100	43
Boscabell Site 20	Pit	C129	1	100	1
Boscabell Site 20	Pit	C235	1	100	60
Boscabell Site 20	Pit	C173	1	100	65
Hughes' Lot East Site 25ii	Pit	C375	1	100	12
Hughes' Lot East Site 25ii	Pit	C375	1	100	47
Hughes' Lot East Site 25iv	Pit	C140	1	100	58
Farranamanagh Site 40	Pit	C15	1	100	1
Toureen Peckaun	Pit	C667	1	100	41
Toureen Peckaun	Pit	C318	1	100	51
Knockadrina	Pit	C152	1	100	1
Knockadrina	Pit	C529	1	100	22
Holdenstown Site 1	Pit	C39	1	100	46
Danesfort Site 6	Pit	C49	1	100	54
Mean saturation point from pit features analysed			**20**	**2000**	**ME 38.95 (±5.22)**

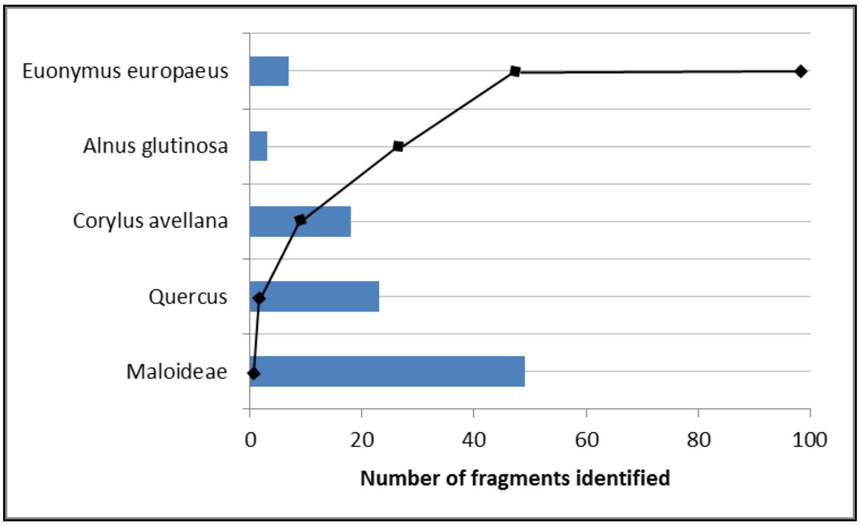


Figure 3.6.5 Saturation curve from pit [1248], Borris, Co. Tipperary (100 fragments identified *Euonymus europaeus* identified at 49)

Saturation curves for posthole/stakeholes

Twenty nine samples from 29 postholes/stakeholes were analysed for sample and fragment sufficiency by plotting the taxa diversity against the number of charcoal fragments identified from each sample **(Table 3.6.5).** The average saturation point for post and stakeholes is 19, or that a minimum of 19 charcoal fragments should be identified from medieval post/stakeholes for meaningful quantitative analysis.

Table 3.6.5 Cumulative saturation values for optimal sampling amounts for postholes showing overall mean (ME± standard error) saturation point value

Site	Feature type	Context no.	No. of samples	No. of fragments	Saturation point
Borris AR33	Posthole	C1796	1	63	16
Monadreela Site 8	Posthole	C172	1	50	28
Hughes' Lot East Site 25ii	Posthole	C397	1	50	1
Hughes' Lot East Site 25ii	Posthole	C407	1	50	1
Hughes' Lot East Site 25ii	Posthole	C723	1	50	1
Hughes' Lot East Site 25ii	Posthole	C331	1	50	16
Hughes' Lot East Site 25ii	Posthole	C387	1	50	29
Hughes' Lot East Site 25ii	Posthole	C333	1	44	11
Boscabell Sie 19	Posthole	C83	1	50	19
Windmill Site 35	Posthole	C46	1	50	1
Toureen Peckaun	Posthole	C392	1	50	1
Toureen Peckaun	Posthole	C873	1	50	12
Toureen Peckaun	Posthole	C998	1	50	31

Toureen Peckaun	Posthole	C206	1	50	1
Toureen Peckaun	Posthole	C275	1	50	22
Toureen Peckaun	Posthole	C154	1	50	18
Toureen Peckaun	Posthole	C291	1	50	27
Toureen Peckaun	Posthole	C348	1	50	23
Toureen Peckaun	Posthole	C441	1	50	15
Toureen Peckaun	Posthole	C740	1	50	12
Toureen Peckaun	Posthole	C508	1	50	33
Toureen Peckaun	Posthole	C522	1	50	17
Farranamanagh	Posthole	C146	1	50	20
Holdenstown Site 1	Posthole	C41	1	50	1
Kilree Site 3	Posthole	C530	1	50	15
Kilree Site 4	Posthole	C271	1	52	3
Knockadrina	Posthole	C245	1	50	15
Knockadrina	Posthole	C249	1	50	19
Knockadrina	Posthole	C279	1	50	27
Mean saturation point from postholes analysed			**29**	**1459**	**ME 19.45 (±1.37)**

Saturation curves for metalworking/charcoal production pits

Nine samples from 9 metalworking/charcoal production pits were analysed for sample and fragment sufficiency by plotting the taxa diversity against the number of charcoal fragments identified from each sample. The charcoal fragments analysed totalled 900 counts **(Table 3.6.6).** The average saturation point for post and stakeholes is 16, or that a minimum of 16 charcoal fragments should be identified from medieval post/stakeholes for meaningful quantitative analysis.

Table 3.6.6 Cumulative saturation values for optimal sampling amounts for metalworking/charcoal production pits showing overall mean (ME ± standard error) saturation point

Site	Feature type	Context no.	No. of samples	No. of fragments	Saturation point
Borris/Blackcastle AR31	Metalworking/Charcoal production	C2044	1	100	33
Borris/Blackcastle AR31	Metalworking/Charcoal production	C308	1	100	18
Borris/Blackcastle AR31	Metalworking/Charcoal production	C539	1	100	38
Borris/Blackcastle AR31	Metalworking/Charcoal production	C562	1	100	11
Borris AR33	Metalworking/Charcoal production	C131	1	100	1
Borris AR33	Metalworking/Charcoal production	C933	1	100	1

Borris AR33	Metalworking/Charcoal production	C1248	1	100	41
Farranamanagh Site 40	Metalworking/Charcoal production	C103	1	100	1
Farranamanagh Site 40	Metalworking/Charcoal production	C104	1	100	1
Mean saturation point from fills analysed			**9**	**900**	**16.11 (±5.68)**

Saturation curves for hearths

Fourteen samples from 12 hearth features were analysed for sample and fragment sufficiency by plotting the taxa diversity against the number of charcoal fragments identified from each sample **(Table 3.6.7).** The charcoal fragments analysed totalled 1100 counts. The average saturation point for post and stakeholes is 22, or that a minimum of 22 charcoal fragments should be identified from medieval post/stakeholes for meaningful quantitative analysis

Table 3.6.7 Cumulative saturation values for optimal sampling amounts for hearth showing overall mean (ME± standard error) saturation point

Site	Context	Feature type	No. of samples	No. of fragments	Saturation point
Gortmakellis	C227	Hearth	1	71	36
Monadreela Site 8	C101	Hearth	1	100	26
Monadreela Site 8	C102	Hearth	1	100	19
Monadreela Site 9	C9	Hearth	1	100	1
Hughes' Lot East Site 25ii	C608	Hearth	1	52	9
Hughes' Lot East Site 25ii	C613	Hearth	1	100	51
Hughes' Lot East Site 25ii	C793	Hearth	3	100	31
Hughes' Lot East Site 25ii	C795	Hearth	1	100	1
Hughes' Lot East Site 25ii	C796	Hearth	1	100	1
Holdenstown	C243	Hearth	1	100	28
Holdenstown	C80	Hearth	1	100	42
Toureen Peckaun	C50	Hearth	1	87	15
Mean saturation point from hearths analysed			**14**	**1100**	**21.66 (±4.86)**

3.6.2 Sample sufficiency for medieval charcoal assemblages

By calculating a T-test to achieve the standard mean saturation points for the six feature types commonly excavated and sampled from medieval occupation and industrial sites, a variance in the optimum number of fragments to be identified per sample is obtained. The mean saturation point is surprisingly much higher than anticipated for many features **(Table 3.6.8).** When these values are graphed using a box plot to denote the maximum and minimum standard errors (95% confidence), there is a significant difference between how these features should be sampled **(Table 3.6.9; Figure 3.6.6).**

The optimum fragment counts required for sample sufficiency differs immensely from site to site and country to country, as previously discussed **(see Chapter 2)**. In relation to Irish archaeological sites, the minimum number of charcoal fragments varies from a high of 80 to a low of 30 fragments per sample. With respect to the medieval features selected to demonstrate this exercise, the mean saturation values from each set of individual feature types fall within these parameters, albeit towards the lower band of 30 fragments per sample. This supports the results from O Carroll's test (2012, 158), where 30 fragments are recommended as an appropriate minimum cut off.

Table 3.6.8 Sample number and fragment counts from the main features to obtain optimal number of fragments to identify per sample

Feature type	No. of features	Mean no. of samples (range)	Mean no. of fragments (range)	Mean saturation point (± SE)
Corn drying kiln	14	3.5 (1-9)	127.28 (100-161)	47.78 (±3.89)
Ditch	14	1	140 (100)	40.14 (±3.24)
Unclassified Pits	20	1	142 (100)	38.95 (±5.22)
Postholes	29	1	52 (44-63)	19.45 (±1.37)
Metal/charcoal production pits	9	1	100 (100)	16.11 (±5.68)
Hearths	12	1.2 (1-3)	79.28 (52-100)	24.44 (±5.66)

Table 3.6.9 Mean fragment counts required to achieve 95% confidence in taxon identification for ranges of margin of error

Feature type	Mean	Standard dev.	Standard error	No. of samples	No. of fragments	Margin of error	Upper 95%	Lower 95%
Kiln	47.8	14.56	3.89	14	1782	7.63	55.41	40.16
Posthole	19.5	7.43	1.37	29	1509	2.70	22.16	16.75
Unclassified Pits	39.0	23.38	5.22	20	2000	10.25	49.20	28.70
Ditch	40.1	12.14	3.24	14	1400	6.36	46.50	33.78
Metal/charcoal pit	16.1	17.05	5.68	9	900	11.14	27.25	4.69
Hearth	24.4	16.98	5.66	9	900	11.09	35.54	13.34

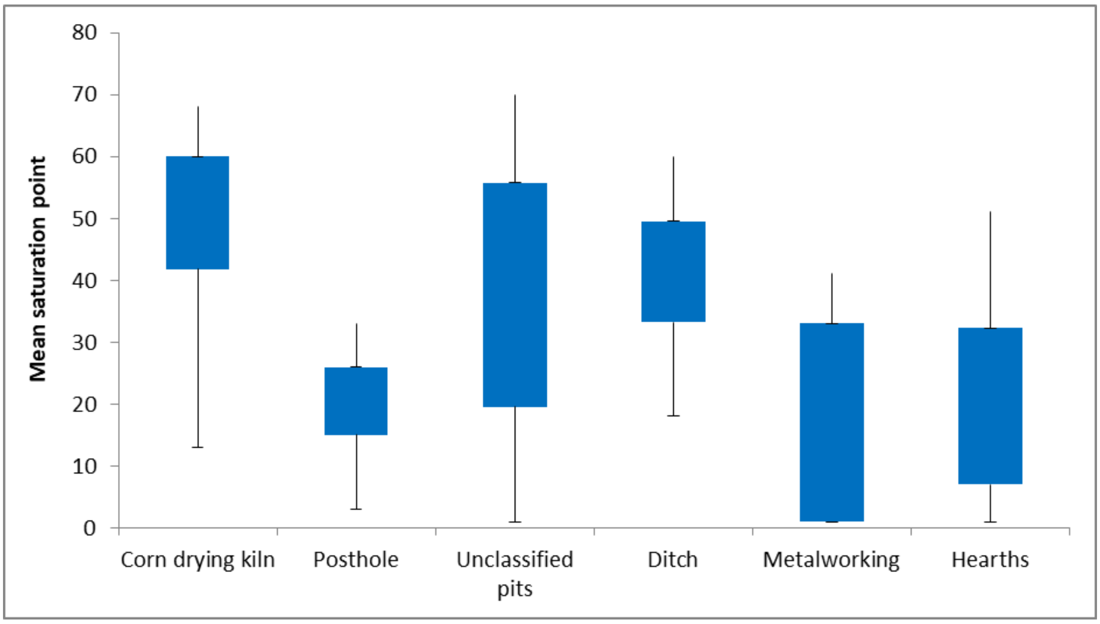


Figure 3.6.6 Mean (±SE) saturation points of the six main feature types analysed for optimal fragment identification

Medieval corn drying kilns have a higher saturation point (48 fragments) than that purported by O Carroll (2012). Medieval kilns were under-represented within the N6 study, with just two identified (O Carroll, 2012, 58) and as such cannot be a robust representation of how corn drying kilns should be sampled. The range of species identified from the kiln features in this study has inevitably increased the saturation point for sample sufficiency to provide a more realistic quantitative method for charcoal recovery from corn drying kilns. The optimum number of samples to be taken from kilns is similar to O Carroll (2012), at a minimum of 6, where at least 7 taxa are represented, however the number of charcoal fragments per sample to be identified should be between 40 and 50 to achieve a good representation of wood taxa diversity.

While many kilns contained low species diversity (i.e Borris/Blackcastle, Boscabell, Knockadrina, Ballykeoghan, Shankill and Templemartin), kilns at Hughes' Lot East, Monadreela, Borris, Holdenstown, Kellysgrange and Milltown comprised a higher variety of wood taxa, where no one species dominated. This higher diversity increases the saturation point for kilns, but also serves to show that activity within each kiln is influenced by factors local only to them and as such these features should be sampled on a site be site basis and interpreted based only on the woods recorded within each feature. Broader inferences should only be made if prior knowns such as archaeological features contemporary with the kiln activity itself are also sampled and interpreted within the context of the site. These would provide comparative control samples to help solidify the integrity of the charcoal remains identified within these features for a more robust interrogation. The results of obtaining an optimum charcoal sampling number for corn drying kilns particularly will prove to be implicit to interpreting the wood taxa from these features in a later chapter.

The saturation point for structural deposits, such as postholes and stakeholes is low at 19 fragments, where only 2 or 3 wood taxa are represented. Using ethnographical studies, it is possible to garner some explanations into the reasons behind charcoal found in structural deposits. Research on house posts using experimental and archaeological studies show that *in situ* charred remains in the base of postholes represent charred post ends, which were burnt prior to their placement, a method used to prevent insect infestation and degradation of the wood (Kahn 2005, 300-301, Kahn and Coil 2006). Charcoal recovered from postholes where 1-3 wood taxa were recorded represents the double or triple replacement episodes of house construction, a practice which is well documented in ethnographical observations (ibid.) In other cases, posthole features which have frequent minute charcoal flecking in their interior fill can be more challenging and are likely to reflect sweeping debris from the dwelling itself that filtered down the posthole profile (Kahn and Coil, 2006, 323). Since these samples are shown to have a higher diversity of wood taxa (>3 taxa), the best way to eliminate this background noise is it take control samples from non-posthole deposits and compare them with sound structural remains (Kahn and Coil 2006, 324, Kahn 2015). Such research offers valuable insights into understanding settlement patterns of rural self-sufficient communities which can contribute to methods and interpretative analysis from an archaeological context.

Figure 3.6.7 below shows that saturation point tends to increase with the number of taxa identified but there is quite a lot of spread to the data indicating that higher saturation points do not necessarily capture more data. The results from the six features analysed show that the samples with the highest saturation points are clustered with the identification of 2, 3, 4 and 5 taxa. Features associated with structural deposits (postholes/stakeholes) have a lower saturation point, which is based on a species dominance (>75%) from these features; oak and hazel from Hughes' Lot East, Monadreela, Borris (AR33), Farranamanagh, Holdenstown and Knockadrina; ash and hazel from Toureen Peckaun. Similarly, the oak dominant composition from metalworking and charcoal production pits, like those at Borris (AR33) and Borris/Blackcastle (AR31), reduces the saturation point for these features.

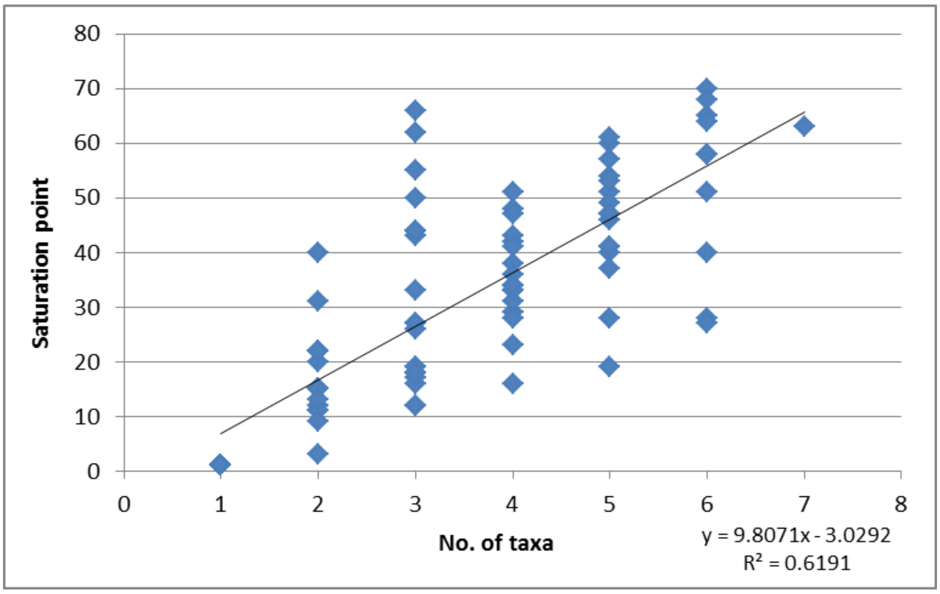


Figure 3.6.7 Saturation point versus number of taxa from all samples analysed

Corn drying kilns, ditches and unclassified pits and hearths all have a higher saturation point of between 4 and 6 taxa. The latter tends to be categorised as representing long term occupation, related to the selection of taxa over a longer period of time, which is criteria for woodland reconstruction (Chabal et al. 1999, Asouti and Austin 2005). These deposits however are shown not to have a high species variation when correlated with short term deposits (reference the feature distribution charts in the results section here). Since charcoal from single phased corn drying kilns are seen to reflect local wood use on a site at any given time, the high variance in wood taxa from these features, is therefore a product of single use site resource supply, rather than an accumulation of firewood from a number of kilning events over time. Consideration has to be given to other activities that are undertaken at a site, and the changes that occur from these activities from time to time, as this is seen to closely influence kiln fuel supply between and within sites.

Sampling should also be on a feature by feature basis and cross correlated to contemporary structures and any ancillary activities undertaken close to the kiln, if available.

Variance in wood taxa from ditch features is also not as high as expected considering that they too are classified as long term stratified deposits (O'Donnell 2011, O Carroll 2012). In most cases, there is a dominant wood species (>50%) from deposits strongly suggesting the remains of a burnt structure e.g. *Alnus glutinosa* dominated from basal ditch deposits at Hughes Lot East, Monadreela and Knockadrina; *Quercus* from Hughes Lot East, Boscabell, Borris, Borris/Blackcastle and Kilree; Maloideae and *Prunus spinosa* at Hughes Lot East, Monadreela and Knockadrina. This composition poses some interesting questions about the exact nature of ditches, particularly enclosure ditches from medieval sites and whether they accumulated as much occupational debris as is often suggested.

The literary sources detail the various types of ditches that existed on a medieval settlement sites i.e. drainage ditches and boundary ditches, and a well-built bank and ditch even added value to the a *cumal* area or land. Designated ditch-diggers are also referenced in the sources as is the illegal digging of ditches and trenches across somebody else's land (O'Kelly 1997, 332). If such activities were worth documenting and incorporated into legal tracts, they would have been a significant component in the context of rural settlement design and aesthetic and as such would inevitably require regular cleaning, maintenance, and management. An accumulation of domestic and industrial debris may have been prohibited in certain contexts or within certain parts of the ditch or on high status sites and so the perception of these features as serving occupational refuse may be over stated.

This offers new insights into how ditches should be interpreted in the archaeological record, particularly the factors that influence sequential deposition representing short and long-term use, re-use or re-cutting of these features in the context of sampling for environmental remains. Therefore the recommendations that only long term occupation deposits and spreads should be used in vegetation reconstructions is not fully accepted in the context of these features.

3.6.3 Testing the "law of fragmentation" for quantification

As has been discussed in Chapter 2 where various approaches to quantifying archaeological charcoal have been argued, the "law of fragmentation" is a quantification method which demonstrates that regardless of species, archaeological wood assemblage mass (charcoal weight) and the number of fragments (charcoal counts) will be correlated (Prior and Williams 1985, Chabal 1991, Shackleton and Prins 1992). If the values for charcoal weights and counts are similar, then either method can be used as a statistical measure for quantifying charcoal assemblages in the archaeological record. To test the validity of the "law of fragmentation" for this dataset charcoal weights and fragments are correlated together to determine if both quantification methods are accordant with each other.

Pearson Product-Moment Correlation co-efficient (PPMCC) was used as a statistical measure whereby Pearson's r value is a measure of the correlation (linear dependence) between two variables giving a value between +1 and -1 inclusive (Dytham 2011). A value close to +1 implies that there is a strong relationship between the two variables. Results from the dataset show that ***r = 0.99*** which purports that charcoal weight and fragments are nearly perfectly correlated (close to +1). The linked relationship between each variable has proven that both weights and fragments can be used independently in analysing the charcoal data from this study and their values are graphed to illustrate this strong correlation **(Figure 3.6.8).** For the purpose of presenting the charcoal data in this thesis going forward, fragment counts will therefore be used.

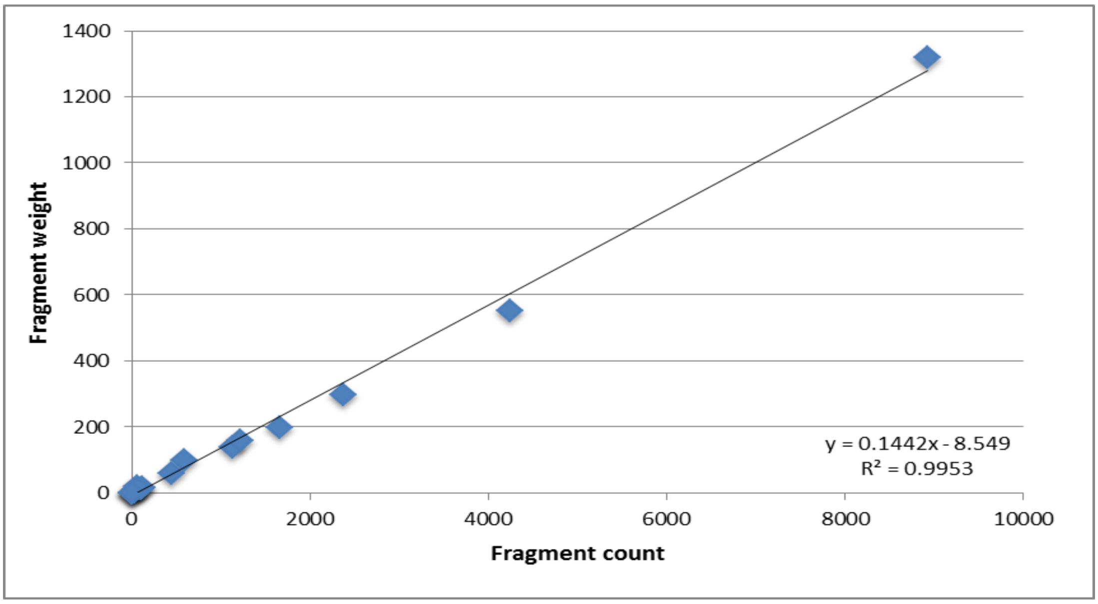


Figure 3.6.8 Correlation between fragment count and fragment weight using PPMCC *(r = 0.99)*

3.7 Wood charcoal identification

The process for identifying wood (charred, dried or waterlogged) is done by comparing the anatomical structure of wood samples with known comparative material or identification keys (Wheeler et al. 1989, Schweingruber 1990, Richter et al. 2004, Wheeler 2011, Hather 2016). The charcoal material is fractured generally by hand to obtain the three section faces necessary for wood identification (transverse, tangential and radial). Identification to species, where applicable, is carried out under a stereomicroscope (10x – 40x) and a universal compound microscope reflected and transmitted light sources at magnifications 100x – 400x.

The precise identification of charred wood can sometimes be problematic. Due to the carbonisation process, key anatomical features, can be altered, deformed or disintegrate as a result of carbonization or other taphonomic processes.

An online atlas devised by the *InsideWood* Working Group (IWG) and hosted by the North Carolina State University is also used to aid identification. The *InsideWood* project (http://insidewood.lib.ncsu.edu) integrates wood anatomical information from the literature and original observations into an internet-accessible database useful for research and teaching. The *InsideWood* database contains brief descriptions of fossil and modern woody dicots (hardwoods) from more than 200 plant families, and is searchable by an interactive, multiple-entry key. This wood anatomy web site has over 35,000 images showing anatomical features with detailed descriptions.

In this study, no differentiation is made between many members of the Maloideae group, which is a sub family of the Rosaceae. This includes the wood species crab apple (*Malus sylvestris),* wild pear (*Pyrus pyraster*), rowan (*Sorbus aucuparia*), whitebeam (*Sorbus aria*) and hawthorn (*Crataegus monogyna*). To establish if it was possible to separate these species within the charcoal assemblage, a sub-sample of 200 Maloideae charcoal were further investigated. These samples were taken from Monadreela Site 9 (Ditch [198]; Fill (116); Sample 17), Windmill Site 35 (Posthole [21]; Sample 8), Hughes' Lot East Site 25ii (Slot trench [325], Sample 39; Ditch [35], Fill (320), Sample 5; Ditch [3], Fill (534), Sample 46; Kiln [308], Fill (797), Sample 147), Hughes' Lot East Site 25iii (Pit [51], Fill (140), Sample 9; Kiln [148], Fill (155), Sample 14) and Knockadrina (Ditch [6], Fill (227), Sample 55; Posthole [310], Fill (312), Sample 69).

To aid this investigation, modern wood samples of *Malus sylvestris*, *Sorbus aucuparia* and *Crataegus monogyna* were sectioned and identified for comparison. On closer inspection of the sub-sampled charcoal remains, particularly the ray composition on the tangential section face, through a process of feature elimination using the anatomical keys on the *Inside Wood* database, the majority of the charcoal (n = 137) contained diagnostic anatomical features strongly resembling *Crataegus monogyna* (hawthorn), particularly from many of the ditch deposits analysed. A further 31 fragments contained diagnostic features resembling *Malus sylvestris*, where ray height and width was broader than other species within this group. None of the sub-sample contained obvious evidence for *Sorbus* sp., which have a more slender, narrower ray width composition than the apple and hawthorn-type and contain gum and other deposits in the heartwood vessels (Wheeler 2011). That said, the taphonomical and carbonisation processes endured by this material cannot be overlooked, which may have altered or destroyed key anatomical features from these species.

It was possible to differentiate between willow (*Salix*) and poplar (*Populus*) based on the heterogeneity of the cells in the radial section of *Salix* (Schweingruber 1990). While willow species exist in greater variation in habit, from large trees to procumbent shrubs, only a few are common or native to Ireland – *S. atrocinera, S. aurita, S.capraea, S. fragilis, S. pentandra,* and *S. repens* (Hather 2016, 110). It is however very difficult anatomically to separate these species and so they are discussed as *Salix* sp. going forward. The cherry species (Prunoideae/Rosaceae.) can also be difficult to separate microscopically and in some cases it was not possible to differentiate between *Prunus avium* (wild cherry) and *P. padus* (bird cherry) and *P. spinosa* (blackthorn), in which case it was labelled as *Prunus* sp. Where good preservation and fragment size allowed however, *P. spinosa* could be confidently identified based on ray width/height and the absence of libriform fibres (Hather 2016, 126).

3.8 Statistical methods

In line with previous charcoal quantitative methods (Asouti 2001, Veal 2009, O'Donnell 2011, O Carroll 2012) percentage frequency analysis (PFA) has been used to establish a basic measure of taxa present so that comparisons in wood variation from different contexts across each site can be investigated. With the "law of fragmentation" now tested and accepted, fragment counts were converted to percentages for PFA interpretation. This approach increases the variability of wood taxon identified at a site the resultant of which will allow for a more informed discussion on woodland management strategies and if it is possible to profile local medieval woodland within the context of each site. To validate the PFA observations, the main results from the dataset were put through a series of multivariate tools in PC-ORD 6 for statistical validation **(see Chapter 4).** Furthermore, to demonstrate the intimacies and intricacies of wood use and change at local level, a series of case studies were selected and similarly scrutinised **(see Chapter 5).**

One of the key aspects of this approach was to highlight the strongest correlations between wood taxa temporally and spatially to allow meaningful interpretation for context-related variability within a robust statistical framework. Since the datasets used in this thesis are primarily associated with human activity through wood selection, it is this factor that proves crucial in the quantitative composition of charcoal assemblages.

Upon reviewing the various statistical methods used for other projects, it was decided that Non-metric Multi-dimensional Scaling ordination (NMS), together with Multi-response Permutation Procedures (MRPP) and Indicator Species Analysis (ISA), all of which are run through PC-ORD 6, were the best tools to use for this study. This combination provided a viable platform for the exploratory analysis of identifying robust patterns within the datasets and to stimulate the development of hypotheses for medieval wood resource use and wood selection. In addition, species diversity and similarity indices, such as Simpson diversity index (Simpson 1949) and Sørensen-Dice Co-efficient for Similarity (Sørensen 1948) were applied to the dataset.

3.8.1 Diversity and Similarity Indices

A diversity index is a quantitative measure that reflects how many different types (wood taxa) there are in a dataset, and simultaneously takes into account how evenly the basic entities (e.g. site types or features) are distributed among those types (Pielou 1969, quoted in Pearsall 2000, 209–10). The value of a diversity index increases both when the number of types increases and when evenness increases. For a given number of types, the value of a diversity index is maximized when all types are equally abundant.

To test diversity among different feature types within the study, the Simpson diversity index was used to measure diversity within ecological groupings. In this case, a ‘sample’ is the combined results from each feature type. Diversity indices are based on the total number of wood species and the total number of individuals in each species. The Simpson index is a dominance index because it gives more weight to common or dominant species **(Figure 3.8.1).** In this case, a few rare species with only a few representatives will not affect the diversity. Species dominance in this dataset is better represented using the Simpson index, producing values more representative to their occurrence within each feature type, particularly where values can change on the basis of abundance.

$$D = 1 - \frac{\sum n_i (n_i - 1)}{n (n-1)}$$	**n = total number of dominant species** **n_i = the number of individual counts from one specific species**

Figure 3.8.1 Simpson Diversity Index Formula (Simpson 1949)

Community Similarity calculates feature similarities (what they have in common in terms of species) and helps determine what features are most similar to each other. Sørenson’s co-efficient is the statistical tool that is used for comparing the similarity of two sets of samples.

Similarity is calculated using the formula:
2C/S1 +S2 where ***C*** is the number of species the two features have in common, ***S1*** is the total number of species found in feature type 1 (e.g kilns), and ***S2*** is the total number of species found in feature type 2 (e.g postholes).

This gives a value between 0 and 1, the closer the value is to 1, the more the sample sets, or in this case, feature types have in common. Complete overlap is equal to 1; complete dissimilarity is equal to 0.This exercise helps to validate the relationship between wood taxa to establish the strongest correlation between each species and what woods were more closely related in the form of occurrence and distribution.

3.8.2 Spearman's rank correlation co-efficient

Spearman's rank correlation coefficient assesses how well the relationship between two variables can be described using a monotonic function. The Spearman correlation between two variables is equal to the Pearson’s correlation between the rank values of those two variables; while Pearson's correlation assesses linear relationships, Spearman's correlation assesses monotonic relationships (whether linear or not). If there are no repeated data values, a perfect Spearman correlation of +1 or −1 occurs when each of the variables is a perfect monotone function of the other. This function was used in interpret the wood variance within each feature type, to establish how the different wood taxa correlated to each other, whether they had a strong or weak relationship within the context of their relative use.

3.8.3 Ordination (NMS)

Ordination arranges items along a scale (axis) or multiple axes to summarises complex relationships, taking one or more dominant patterns from an infinite number of possible patterns (McCune and Mefford 2011). Non-metric multi-dimensional scaling (NMS) is the statistical tool used here to assist interpretation and discussion. In ordination space, similar samples are grouped closest together, with axes describing the gradients of highest variance. NMS is used in the study to observe patterns in the data, particularly between site/feature types, and time periods and to establish if there is any significant correlation between wood species and specific domestic, craft or industrial activities.

NMS starts the configuration for the best solution by using 'auto-pilot' runs ('seed' number) which generates up to 250 random runs on each real dataset. This produces a dimensionality of axes from highest to lowest. NMS was used for this purpose as it is suited to arbitrary or non-normal data distribution in addition to datasets that have a high number of zero values. This application searches for the best positions of *n* entities on *k* dimensions (axes) which minimises the stress of the *k*-dimensional configuration. The main parameter used in this method is to select a suitable distance measure, which are tools that estimate the degree of dissimilarity between sample units based on the number of species in the dataset and their pattern of co-occurrence.

Previous research has demonstrated that the Sørensen index is the most suitable for statistically interpreting palaeoenvironmental data (Reilly 2008, Stefanini 2008, O'Donnell 2011). The best solution is selected for each dimensionality i.e. the lowest final stress from a 'real' run. PC-ORD selects appropriate dimensionality by comparing the final stress values among the best solutions, one best solution for each dimensionality. The final dimensionality is chosen on the basis that the stress must be ***lower than that for 95% (5-20)*** of the randomized runs (i.e. $p = < 0.05$ for the Monte Carlo test). If this criterion is not met, PC-ORD chooses a lower dimensional solution, provided it passes the Monte Carlo Test. This process is then repeated, using the selected dimensionality, selected distance measure and the starting configuration for the best solution in the auto-pilot runs ('seed' number). Stability is checked by using the plot vs. iteration graph and the final instability value for the chosen solution.

In general, the basic principles for choosing the best NMS solution are:

- select an appropriate number of dimensions
- seek low stress (<20)
- use a Monte Carlo test to achieve less *p*-value (≤ 0.05)
- avoid unstable solutions

The NMS programme also provides a correlation co-efficient r measure for each wood species. The correlation co-efficient displayed is Pearson's *r*-value (Waite 2000). In statistics the correlation co-efficient measures the strength and direction of a linear relationship between two variables on a scatterplot. The value of *r* is always between +1 and –1. Values close to +1, denotes a strong positive linear relationship, while values close to -1 show a strong negative linear relationship. Whether the result is **+** or **-** , as long as the relationship displays a linear pattern, the data is interpreted as statistically viable. The analysis of the dataset followed these general rules and a summary of the findings are presented in the results chapter **(Chapter 4)** and by site and feature in the case studies chapter **(Chapter 5).**

3.8.4 Indicator Species Analysis

Indicator Species Analysis (ISA) through PC-ORD 6 (McCune and Mefford 2011) is used to determine the affiliations of taxa to particular time periods, features and site types (McCune et al. 2002). Values ***greater or equal to 25*** suggest that a species is a good indicator for that group (Dufrene and Legendre 1997). Statistical significance of groups is determined by a Monte Carlo randomisation test where the null hypothesis is that the species have no value as indicators (Kent 2011) and affirmed by a *p*- value of ≤ 0.05. Computation is based on abundance as well as frequency of a species. These affiliations can help towards the re-constructing of woodland types pertaining to a specific period or wood selection in relation to specific wood use.

Indicator Species Analysis was also used to compare wood taxa geographically and chronologically. It was also run on all feature types that were represented within the study areas to demonstrate the strongest trends – structural (postholes, stakeholes, slot trenches), corn drying kilns, metalworking pits, charcoal production pits, unclassified pits (scorching), unclassified pits (no scorching), ditches, linears, souterrain deposits and spreads. This test also proved useful in line with NMS and MRPP when comparing wood taxa with cereal crops from corn drying kilns. The programme was run 3 times to confirm a viable output with a statistically low *p*-value.

3.8.5 Multi-response permutation procedure (MRPP)

Multi-response Permutation Procedures (MRPP) using relative species abundance data to conduct a permutation test for differences between or among groups of sample units based on within-group similarities (McCune et al. 2002). MRPP does not require equal sizes among groups and is a useful tool for evaluating hypotheses whenever sample units can be assigned to discreet groups. It compares the observed intragroup average distances with the average distances that would have resulted from all the other possible combinations of the data under the null hypothesis (Cade and Richards 2005).

The main purpose of this analysis is to test whether there were statistical differences in the charcoal data between time periods and site/feature types. The results will validate whether the observations made on sample composition relating to period and site/feature type can be reproduced through MRPP. These results are based on permutations (identity and abundance of taxa) between the identified taxa and archaeological variables which include time periods and feature types. The T statistic indicates the degree of separation between groups (more negative indicates greater separation), and has an associated p-value. However, the p-value is not independent of sample size, so the chance-corrected within-group agreement statistic, A, is calculated; $A = 0$ if the average within-group distance is equal to that expected by chance, $A > 0$ if average within-group distance is more than that expected by chance (McCune and Dixon 2006). Just because wood taxa in a group are more similar to one another than they would if they belonged to a different group, does not mean that they are similar to each other within their group setting.This test helped to strengthen the results of the NMS and ISA to ascertain the strongest correlation between groups (feature, site and time period).

The methodology used in this research is therefore a combination of standard methods such as percentage frequency analysis (PFA), strengthened by the application of a series of statistical tools (Simpson Index; Sørensen-Dice Co-efficient; NMS; ISA and MRPP) for interpreting species similarity/diversity, context-related variation and chronological change.

3.9 Bayesian modelling

3.9.1 Background to methods

The Bayesian approach to interpreting archaeological data is based on the principle that while the calibrated age ranges of radiocarbon measurements estimate the calendar ages of the samples themselves, it is the dates of archaeological events associated with these samples that are important to archaeological interpretation. The techniques used in Bayesian analysis provide quantitative estimates of the dates of such events (posterior beliefs) through two main strands of data; relative dating methods (stratigraphy and artefact typologies) and absolute dating evidence (radiocarbon dating) (Bayliss et al. 2007, 5). Archaeological stratigraphy can be used to reduce the uncertainty in both individual calibrated radiocarbon dates and the overall sequence of events by taking into account that samples lower down in a sequence are earlier than those higher up (assuming that no truncation or disturbance of layers is evident).

In the absence of good stratigraphical sequencing, the radiocarbon dates themselves are used as a way of constraining the calibrated start and end ranges (assuming that they can be attributed to a continuous phase of activity). These posterior beliefs are then expressed as probability distributions or 'posterior density estimates', once all relevant archaeological evidence has been taken into account (ibid.). These are not absolute dates and will change as additional data is added or remodelled. In the event that specific events, such as the beginning or end of an activity, are not dated directly by radiocarbon measurements, but where a number of radiocarbon determinations exist within this sequence, it is possible to calculate more accurately a distribution for such events using the Bayesian method (Bayliss and Woodman 2009, 109).

By using these multiple measurements, estimated dates for the start or end of an event can be achieved. These estimates can then be compared to calculate and refine the probability distributions of activities and events across a site. The method commonly used in creating chronological models where radiocarbon samples from the posterior distribution are rare is Markov Chain Monte Carlo (MCMC) (Ramsey 1995, Ramsey 2009a, Ramsey and Lee 2013). These types of modelling techniques using MCMC are now widely used and are available in software packages such as OxCal.

3.9.2 Developing a Bayesian Model

When constructing a Bayesian chronology, the calibrated radiocarbon dates for the 'standard likelihoods' component of the model and archaeology provides the 'prior beliefs'. The radiocarbon dates are therefore reinterpreted in light of the archaeological information in order to provide posterior beliefs about the dates being modelled. Bayesian chronologies provide conceptual models that are contextual and interpretative. Based on the number of radiocarbon dates used and how these dates are arranged within query building exercises, models will inevitably change and alter in different ways.

Uninformative prior beliefs

Uninformative prior beliefs are calibrated radiocarbon dates that are related to or associated with a particular activity (e.g. the construction of a ditch). There is little definite information about the problem, but it's included to avoid bias in the model (Steier and Rom 2000, Bayliss et al. 2007, 8-15).

Informative prior beliefs

This is where there is specific archaeological information that can be incorporated into the model. Informative prior beliefs derive from the relative dating evidence provided by stratigraphic relationships between radiocarbon samples. The relative sequence of deposition of the archaeological contexts ordered within a Harris matrix provides this type of information (Bayliss et al. 2011, 27). To use this relative dating of contexts as a prior belief, it is important that the order of the contexts is the same as the order in which the dated organism died.

Standardised likelihoods

These take the form of dates derived from scientific methods (radiocarbon dates or dendrochronological dates) and on occasion dates from documentary sources or coins/inscriptions. In this study, all of the standardised likelihoods come from radiocarbon dates.

3.9.3 The Bayesian process

An iterative approach to selecting radiocarbon dates for chronological modelling has been refined through practice into a standardised methodology by English Heritage (Bayliss and Ramsey 2004, Whittle et al. 2011), as demonstrated by **Figure 3.9.1** below. Once an interpretation of the site chronology has been established based on existing information, consideration is given to the types of queries the dating programme should be designed to address. In addition to the main project aims **(Chapter 1)**, attention was given to other subsidiary site-related objectives that may relate to the development or duration of a specific feature(s) or a series of sites/activities located in the surrounding area (e.g corn drying kilns). Formulating explicit research objectives is a crucial part of the Bayesian modelling process, since the aims essentially affect the type of model that will be constructed (Whittle at al. 2011, 37).

The three basic criteria for assessing a sample were as follows:

- that the samples were determinations obtained from short-lived species, rather than long-lived charcoal (i.e. the 'old wood effect' (Bowman 1990))
- that the sample had not been contaminated by a carbon containing material
- that the sample was securely associated with the archaeological activity of interest (Waterbolk 1971)

Once the components of the Bayesian model were assembled – the standard likelihoods obtained and the prior beliefs defined – they were put through the programme. This is done using the Markov Chain Monte Carlo (MCMC) random sampling technique in OxCal. For this study, all modelling has been carried out using OxCal v4.3.1 (Ramsey 2009b) and the current internationally agreed atmospheric calibration dataset for the northern hemisphere, IntCal09 (Reimer et al. 2009). To assess the reliability of the models, two statistical indices were used by OxCal; (**A:)** and (**$A_{overall}$:)** (Ramsey 1995, 249, 429).

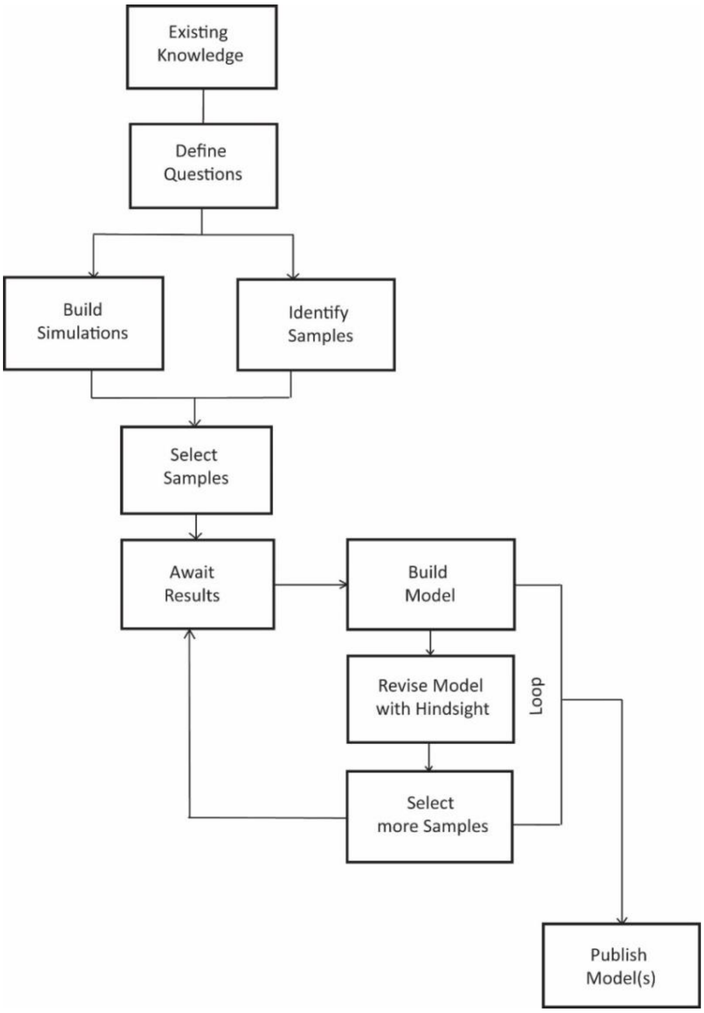


Figure 3.9.1 Flow diagram showing stages of sample selection for chronological modelling (after Whittle et al. 2011, 32)

The (A:) index provides a measure of how well the posterior density estimate agrees with the standardised likelihood from which it derives. If the posterior density estimate is in a high-probability region of the likelihood, the index agreement will be high; if it falls in a low probability region, it will be low. The index of agreement should be greater than 60% for reliability. In cases where there is a low index of agreement, it may merely indicate that the radiocarbon date is a statistical outlier, however very low agreement may suggest that a sample is residual or intrusive.

The ($A_{overall:}$) tests the overall index agreement which is calculated using the individual agreement indices. This provides a general measure of the consistency between the prior information and the standardised likelihoods. The overall index of agreement also has a threshold value of 60%. To determine if each model is stable and robust, OxCal also conducts a convergence test, which measures how quickly the MCMC sampler is able to produce a representative and stable solution to the model (ibid.). In practice, a model with a poor convergence value (<95%) is deemed unstable and results should not be used.

3.9.4 Bayesian chronological modelling for this thesis

For the purpose of this thesis, a series of Bayesian models (Bayliss et al 2007; Buck et al 1996) were constructed to help refine the chronology for sites to allow for a more robust interpretation of the wood species data. All radiocarbon dates used were calibrated in OxCal 4.3.1, using IntCal 2009 (Reimer et al. 2009).

The main objectives for this action include:

- To provide a more precise and robust dating for a site
- To estimate the duration of the use of a site, feature or set of features
- To check the chronological relationship of on-site features and closely linked sites
- To establish patterns of change between early and later activity at a site/feature

This places each activity at a site more firmly within the context of its use and allows for a reassessment of the original interpretation of the activities undertaken on each site.

A typical Bayesian in-depth modelling approach incorporates *a priori* knowledge of the stratigraphic relationships between the radiocarbon dates for a site. As will be demonstrated by the individual site models in this thesis, the 'Sequence' code in OxCal it used to construct a chronologically constrained series of radiocarbon dates. This method works where there is a well-designed dating strategy on a well-defined stratgraphical sequence. While this approach greatly enhances our understanding of a single site chronology, there are issues when using it to cross-compare a substantial number of sites (Kerr and McCormick 2014, 494). One approach (e.g. Riede and Edinborough 2012) to challange this has been to treat dates from various sites as it relies on a simple sequence of radiocarbon dates organised by age.

To facilitate chronologically-based research questions, implementing Bayesian modelling in such a manner is on the increase, particularly from sites where discreet features represent a specific activity or single phased event. Examples of this are found in Wicks et al. (2014) where the Bayesian models for five Scottish sites are combined to create summed probability distributions for the Oronsay and Storakaig Mesolithic midden dates. Similar work by Bayliss et al. (2011) on a number of hillforts in southern England and Ireland also constitutes a more comparable data sample. The aforementioned work on refining rath/ringfort chronology by Kerr and McCormick (2014) also uses this practice where 255 dates from 85 sites were modelled to produce a methodology that reduced the visible impact of dating fluctuations to constrain the significant phases of rath construction and occupation (Kerr and McCormick, 2014).

As stated previously, Bayesian chronologies are conceptual models and so the *posterior density estimates* produced by the modelling of the dataset in this study are not absolute. They are interpretative *estimates* which are understood and discussed within the context of the queries proposed for this study and so will inevitably change if modelled from a different perspective.

3.10 Case Studies

To understand and contextualise the patterns of wood use and change at site level during the medieval period three sites and one feature-type were selected as case studies to investigate wood use for particular activities in more detail **(Chapter 5).** Through the use of various statistical tools and Bayesian chronological modelling, any changes that occurred to this resource chronologically across a local (site) and extra-local (landscape) area were also investigated. These sites include: Twomileborris (Borris and Blackcastle Site AR31 (E2374) and Borris Site AR33 (E2376); Hughes' Lot East (Sites 25ii, 25iii and 24iv (03E0730/03E0746/03E0807) and Toureen Peckaun (05E0247).

In addition to modelling the site chronologies, a Bayesian approach was also used to interrogate the chronology of corn drying kilns, one of the most prolific archaeological features analysed as part of this study to understand context-related wood use from single/short phased activity. These features are unique in the archaeological record as they represent a clear type of function (crop drying); if found undisturbed can contain one or more phases of sequential use and are almost always radiocarbon dated using single entity short-lived archaeobotanical remains (e.g. cereal grain).

The objective of this approach was to use the composition values of the wood taxa in each kiln to establish the currency of their use within the context of their site and wider landscape. This would provide estimates for the earliest and latest use of wood taxa or groups of taxa which would allow for a more exploratory assessment of wood change over the course of forming part of a broad chronological sequence. This rudimentary use of Bayesian analysis is not based on the stratigraphical relationships between the various sites, but instead the medieval period and how patterns of wood use were related to socio-economic and cultural vagaries reflected in the archaeological and historical record.

While much of the current research on medieval corn drying kilns in Ireland deals with their form, morphology, distribution patterns and functionality through archaeobotanical evidence (plant macrofossil remains) **(see Chapter 5)** the type of woods used to fuel and construct these features still remains elusive. Collating a charcoal dataset from 51 corn drying kilns will form the first landscape-wide study of these medieval features with respect to the wood taxa found within them. Using quantitative methods through a series of statistical tools and Bayesian modelling will provide a robust examination of how kilns were utilising in the medieval period, how their fuel selection was determined, their on-site management and maintenance and if any changes to patterns of wood use within these features can be deduced. In turn this will provide insights into the type of wood acquisition strategies at play during the medieval period and if this activity had any socio-economic or cultural relevance.

To fully assess the nature of wood resource use within and between these sites, the following criteria were adhered to during sample selection:

- Features representing a cross section of medieval occupation and industrial activity
- Primary and secondary deposits containing charcoal material
- Single and multiple phases of activity
- Suitable number of samples representing these phases

- Sufficient dating chronology
- Comparative archaeobotanical (plant macrofossil) material for corn drying kiln analysis

3.11 Conclusions

Upon evaluating the various methods and approaches for sampling charcoal and quantifying datasets for feature and site interpretation, a suitable methodology has been devised for this thesis. By objectively scrutinising the current procedures used to identify, quantify, qualify and interpret archaeological charcoal remains, a robust methodology has been devised for medieval dated features in an Irish context.

The best method for quantifying charcoal for this study has also been tested. By agreeing with the "law of fragmentation", the fundamental model for charcoal quantification, it has been deduced that counting charcoal fragments and converting them to percentages is a suitable quantification method for this dataset. In turn, this exercise has supported and further strengthened the procedures for charcoal sample sufficiency in the broader archaeological record.

Through saturation curve analysis, an optimum minimum fragment count for a variety of features associated with medieval settlement and activity has been obtained. The recommended number of charcoal fragments to attain sample sufficiency for medieval dated features, is 48 fragments, which will provide an optimum minimum for meaningful statistical interpretation of wood use. Each of the sites/features included in this study has reached this threshold and so qualifies for integrated archaeological interpretation. This is slightly higher than the recommendations by O Carroll (2012) (minimum 24 fragments); much lower than the optimum fragment count by O'Donnell (2011) (80 fragments) and more in line with Stuijts (2006), where a minimum of 50 fragments be analysed as a sufficient representative of wood taxa remains.

A review of current statistical packages and practices demonstrated that multi-variant analysis through PC-ORD (version 6) was deemed most suited to the irregular and arbitrary distribution of archaeological charcoal. The results of these applications are outlined in Chapter 4, which presents the observed trends and patterns that have emerged from this extensive and complex dataset. In addition to this, the results of the Bayesian chronological modelling for site chronologies and context-related activity are presented for each case study in Chapter 5.

4 Results

4.1 Introduction

This chapter presents the overall results of the charcoal analysis carried out from this study. To establish general patterns in the dataset, the results were plotted by site, by feature type and by period using percentage frequency analysis (PFA). To verify the main observations examined through PFA, the results were put through a number of statistical tests (NMS, MRPP and ISA) to aid in the exploration of new hypothesis made possible by query building the datasets. These methods allowed sample units to be compared statistically by phase, by site and by feature type to highlight context-related variation and to ascertain changes to wood use over the course of the medieval period. A full list of all the wood taxa identifications by site and by feature, can be found in the **Appendix 3.** For the purpose of this chapter, all results are presented in graph form and, where applicable, tables for illustrative purposes.

To test wood variance, use and change at site level, with a view to understanding and interpreting broader trends in resource use, a series of case studies modelled through Bayesian analysis were used on sites located within a confined geographical landscape containing a continuity of archaeological activity spanning the early to the later medieval period. These methods were also used to investigate wood resource use from corn drying kilns, a frequent feature type within the study and indeed one of the most ubiquitous features found on medieval Irish sites.

4.2 Overview of sites analysed

The 49 sites selected as part of this study represent a cross section of early, high and later medieval rural settlement site types. Twenty four sites were dated to the period 400AD – 800AD; 5 sites dated to the medieval period 400AD – 1200AD; 5 sites contained activity dating to between 400AD – 1200AD; 13 sites dated to the late medieval period (post-1200AD), while 1 site, was comprised of continuous archaeological activity that dated from the early medieval period (seventh century AD) through to the fifteenth century AD (Toureen Peckaun, Co. Tipperary) **(Figure**

4.2.1). In the case of Toureen Peckaun, the charcoal assemblage largely represents the activity dating from the sixth to the eleventh century AD. The later phase of the site was characterised by the cemetery and burial evidence and did not provide a sufficient record of features or samples containing charcoal for analysis.

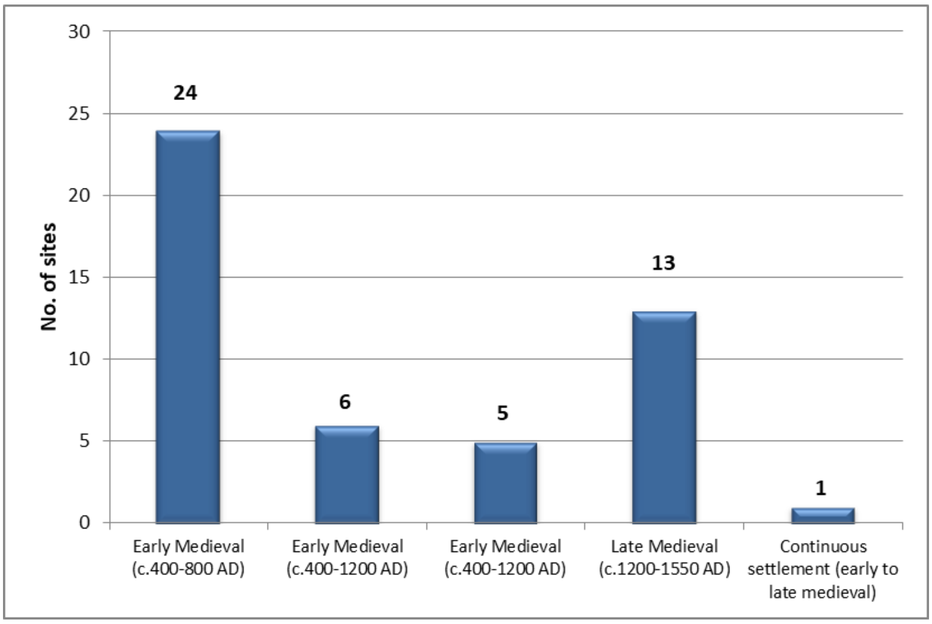


Figure 4.2.1 Number of sites by period

The range of medieval sites identified and excavated along the N8/M8 (Tipperary) and N9/N10 (Kilkenny/Carlow) scheme included a series of early and late medieval enclosed settlements, which comprised one or more circular and rectilinear structures, defined by postholes, stakeholes and slot trenches, along with associated hearths, pits and floor deposits **(Figure 4.2.2.2)** These sites also included typical working and industrial areas, such as corn drying kilns, metalworking and charcoal production pits, in addition to linears, one or more enclosure ditches, spreads and unclassified pit features. The remains of four early medieval enclosed settlement complexes were investigated in County Tipperary —Hughes' Lot East (Sites 25ii-iv), just 1km east of the medieval town of Cashel, Boscabell (Sites 19-20), approx. 1km to the north, Gortmakellis (AR01), just 2km to the north of the latter and Borris (AR33) situated approx. 20km north of Cashel.

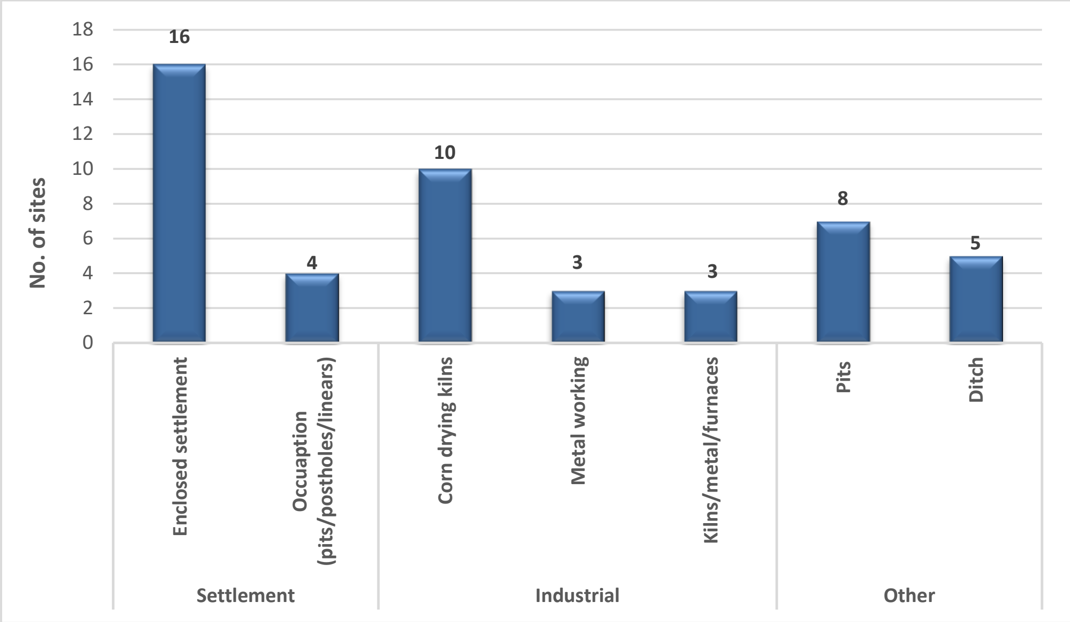


Figure 4.2.2 Number of site types analysed

A series of early medieval enclosure sites were also identified in County Kilkenny, such as Coneykeare, approx. 15km northeast of Kilkenny city, Tinvaun and Kilree (Site 4), situated approx. 10km to the east and southeast of Kilkenny and Knockadrina, some 20km to the south. The early medieval sites at Holdenstown (Site 1) and Kilree (Site 3), just 5km apart approx. 10km from Kilkenny City were both classified as enclosed secular settlement-cemetery sites, where people lived, worked and buried their dead. Here evidence for structures, crop drying and metalworking were all recorded together with contemporary burial activity dating from the sixth to the tenth century AD.

Late medieval enclosure settlements, defined by ditches, with structures and working areas were recorded at Monadreela (Sites 8-12), just 3km northeast of Cashel town. At Borris/Blackcastle (AR31), a later occupation of the aforementioned early medieval Borris complex (AR33), an extensive industrial area dating to between the thirteenth and sixteenth century was identified which included a vertical water-mill, corn drying kilns, metalworking features (furnaces and smithing hearths) and associated structures. Sites containing evidence for occupational activity in the form of postholes, ditches and pits, but where no defined enclosure ditch was evident included the early medieval site at Moycarkey Site 12/13, approx. 10km north of Cashel. While defined as isolated features within the context of the area excavated, nearby recorded enclosure sites (RMP: TN047-65; 66; 67; 70) within a 300m zone cannot be overlooked with interpreting these features. Similarly, the eleventh/twelfth century AD kiln and pits at Rahard and Scart, approx. 2.5km south of the village of Mullinavat in the south of County Kilkenny was located less than 20m west of a known enclosure site (RMP: KK040-069) and the early and late medieval sites at Danesfort Site 5 and Site 6 less than 10km from Kilkenny City were in the vicinity of enclosures (RMP: KK023-057; 058), a designed landscape (RMP: KK023-080001) of extensive ridge and furrow lands (RMP: KK023-060).

A series of sites containing clear evidence for early medieval industrial activity, in the form of corn drying kilns, metalworking and furnaces, were also present within the study area. While many of these sites were not intimately associated with known medieval enclosures or other site types and are interpreted as somewhat isolated groups of features, some examples are found close to known recorded monuments. At Ballydavid, Co. Tipperary the early medieval corn drying kiln and a series of postholes/pits recorded were located less than 200m from two substantial ringfort sites (RMP: TN048-005; 006). The early medieval kilns identified at Monadreela, Co. Tipperary (Site 5 and Site 11) were within the vicinity of a series of enclosure sites recorded at Ballyknock Hill (RMP: TI061-008; 009, 010).

The corn drying kilns at Scart, Co. Kilkenny were located immediately north of ringfort and souterrain (RMP: KK040-05201-02). Those at Templemartin (Site 1) were located close to early medieval enclosure (RMP: KK020-027). The corn drying kilns identified from Baysrath (AR53-54) approx. 10km south of Kilkenny city and 2km from Knocktopher village were located 30m outside the main medieval enclosure settlement and cemetery complex excavated. A cluster of 9 corn drying kilns at Kellysgrange Site 3, Co. Kilkenny were situated within a rich archaeological landscape, with ringfort (RMP: KK027-003) and enclosure site (RMP: KK027-034) just 1km away, along with a suite of ecclesiastical enclosures and complexes, at Kilree (RMP: KK027-044), and Jerpoint (RMP: KK028-062005) within a 5km radius of the site. These sites classified as isolated industrial or working areas should therefore be considered within their wider landscape, particularly when located close to known recorded sites and monuments.

4.3 Wood charcoal identification results

4.3.1 Total charcoal identifications

A total 20,953 charcoal fragments from 664 samples were identified collectively from the 49 sites analysed **(Table 4.3.1).**

Table 4.3.1 List of samples and charcoal fragments per site

County	Site name	Site type	Time period	No. of samples analysed	Charcoal counts
Tipperary	Gortmakellis	Enclosed settlement	Early medieval	20	451
Tipperary	Ballydavid	Industrial: Corn drying kiln	Early medieval	6	214
Tipperary	Moycarkey Site 12	Occupation	Early medieval	1	70
Tipperary	Moycarkey Site 13	Pits	Early medieval	2	115
Tipperary	Moycarkey Site 15	Iron working	Late medieval	2	115
Tipperary	Borris AR33	Enclosed Settlement	Early - High medieval	27	1058
Tipperary	Borris & Blackcastle AR31	Industrial: Kiln/Metal/Mill	Late medieval	17	974
Tipperary	Monadreela Site 5	Industrial: Corn drying kiln	Early medieval	1	100
Tipperary	Monadreela Site 8	Enclosed settlement	Late medieval	13	322
Tipperary	Monadreela Site 9	Enclosed settlement	Late medieval	13	461
Tipperary	Monadreela Site 11	Enclosed settlement	Early - Late medieval	35	598
Tipperary	Monadreela Site 12	Enclosed settlement	Late medieval	3	139
Tipperary	Boscabell Site 19	Enclosed Settlement	High medieval	12	354
Tipperary	Boscabell Site 20	Enclosed Settlement	Early medieval	15	613
Tipperary	Hughes-Lot East Site 25ii	Enclosed settlement	Early - High medieval	139	2826
Tipperary	Hughes-Lot East Site 25iii	Ditch	Early medieval	2	69
Tipperary	Hughes-Lot East Site 25iv	Enclosed settlement	Early medieval	19	521
Tipperary	Farranamanagh	Industrial: Metal/furnace	Early - High medieval	27	582
Tipperary	Windmill	Pits	Late medieval	8	223
Tipperary	Toureen Peckaun	Monastic settlement	Early - Late medieval	58	2540
Kilkenny	Baysrath Site AR53/54	Settlement complex/cemetery	Early medieval	6	299
Kilkenny	Tinvaun Site 3	Pits	Early - High medieval	16	515
Kilkenny	Knockadrina	Enclosed settlement	Early medieval	33	1181
Kilkenny	Kellysgrange	Industrial: Corn drying kiln	Early medieval	18	689
Kilkenny	Holdenstown Site 1	Enclosed settlement	Early medieval	9	393
Kilkenny	Holdenstown Site 2	Cemetery settlement	Early medieval	17	461
Kilkenny	Danesfort Site 5	Pits	Early medieval	7	139
Kilkenny	Danesfort Site 6	Occupation	Late medieval	10	380
Kilkenny	Kilree Site 3	Cemetery settlement	Early medieval	47	809
Kilkenny	Kilree Site 4	Enclosed settlement	Early medieval	17	679
Kilkenny	Templemartin	Industrial: Corn drying kiln	Early medieval	2	100
Kilkenny	Kellysmount	Pits	Early medieval	2	50
Kilkenny	Milltown Site 3-5	Industrial: Kiln/Metal	Early medieval	16	789
Kilkenny	Ballykeoghan	Industrial: Corn drying kiln	Early medieval	4	103
Kilkenny	Jordanstown	Pits	High medieval	3	124

County	Site name	Site type	Time period	No. of samples analysed	Charcoal counts
Kilkenny	Scart	Industrial: Corn drying kiln	High medieval	1	248
Kilkenny	Shankill Site 2	Industrial: Corn drying kiln	Late medieval	2	75
Kilkenny	Shankill Site 5	Pits	Late medieval	2	100
Kilkenny	Leggetsrath East	Occupation	Late medieval	7	249
Kilkenny	Scart & Rahard	Industrial: Corn drying kiln	Late medieval	1	50
Kilkenny	Coolmore	Industrial: Corn drying kiln	Late medieval	3	310
Kilkenny	Earlsrath Site 32	Ditch	Early medieval	4	166
Kilkenny	Earlsrath Site 33	Ditch	Late medieval	2	57
Kilkenny	Earlsrath & Ballylusky	Metal working	Early medieval	1	50
Kilkenny	Rahard West	Occupation	High medieval	2	200
Kilkenny	Riceland	Ditch	High medieval	1	52
Carlow	Moanduff Site 1	Pits	Early medieval	3	67
Carlow	Moanduff Site 2	Industrial: Kiln/Furnace	Early medieval	3	144
Carlow	Coneykeare	Enclosed settlement	Early medieval	5	129

The 20,953 charcoal fragments with a combined weight of 2891.76 grams were extracted for wood species identification analysis and interpretation **(Table 4.3.2; Figures 4.3.1, 4.3.2).**

Table 4.3.2 Total number of taxa identified and weights (%)

Taxon	Total Counts	% of Total Counts	Total Weight (g)	% of Total Weights
Quercus sp.	8988	42.9%	1319.6	45.6%
Corylus avellana	4203	20.0%	552.9	19.1%
Fraxinus excelsior	2365	11.3%	297.9	10.3%
Maloideae spp.	1603	7.6%	195.8	6.8%
Alnus glutinosa	1156	5.5%	137.8	4.8%
Salix sp.	1116	5.3%	158.6	5.5%
Prunus sp.	608	2.9%	97.1	3.4%
Prunus spinosa	435	2.0%	57.9	2.0%
Prunus avium/padus	116	0.6%	13.4	0.5%
Betula sp.	110	0.5%	16.8	0.6%
Euonymus europaeus	80	0.4%	12.2	0.4%
Ulmus sp.	71	0.3%	19.7	0.7%
Ilex aquifolium	54	0.2%	8.5	0.3%
Taxus baccata	38	0.2%	3.0	0.1%
Ulex sp.	5	0.02%	0.1	0.00%
Hedera helix	2	0.00%	0.1	0.00%
Carpinus sp.	2	0.00%	0.2	0.01%
Frangula alnus	1	0.00%	0.1	0.00%
Total	**20953**	**100%**	**2891.76g**	**100%**

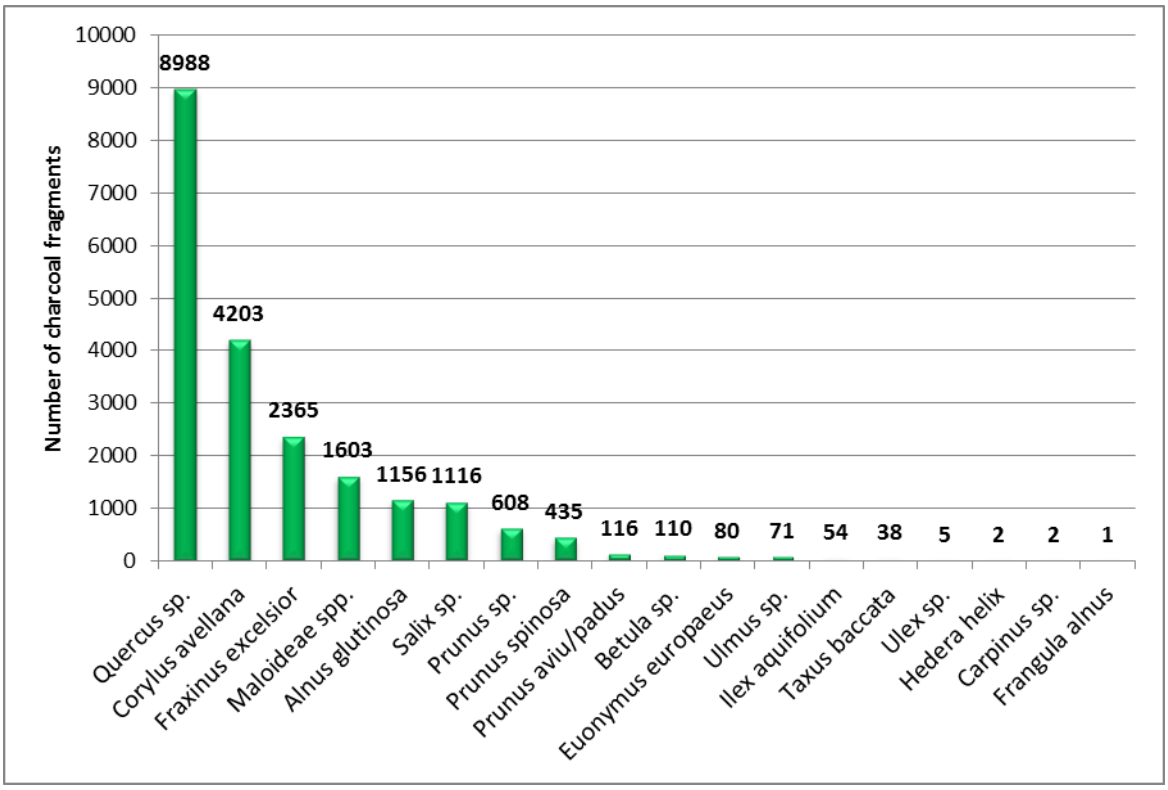


Figure 4.3.1 Total number of charcoal fragments identified (n = 20, 953)

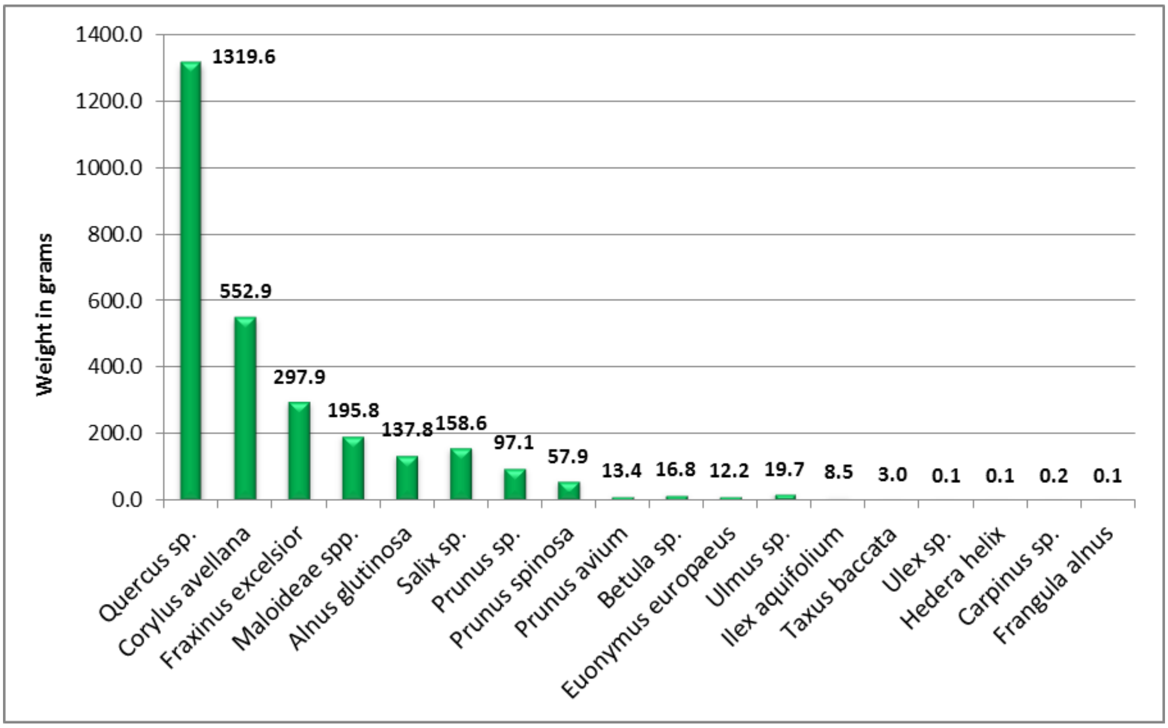


Figure 4.3.2 Total weight (g) of charcoal fragments per taxa (weight = 2891.76 g)

Eighteen wood taxa were identified where *Quercus* sp. (oak) dominated overall accounting for 43% (8988 counts) of the charcoal assemblage, followed by *Corylus avellana* (hazel) which made up 20% (4203 counts). *Fraxinus excelsior* (ash) accounted for 11% (2365 counts); Maloideae wood species represented 8% (1603 counts) while *Alnus glutinosa* (alder) and *Salix* (willow) made up 6% (1156 counts) and 5% (1116) respectively.

The *Prunus* species were sub-divided into *Prunus spinosa* (blackthorn), *Prunus avium*/*padus* (wild/bird cherry) and indeterminate (*Prunus*-type), which made up 2% (435 counts), 0.6% (116 counts) and 3% (608 counts) of the overall charcoal assemblage. Just 0.5% (110 counts) were identified as *Betula (*birch), with *Taxus baccata (*yew), *Ilex aquifolium* (holly), *Ulmus* (elm), *Euonymus europaeus* (spindle), *Hedera helix* (ivy), *Ulex europaeus* (gorse), *Carpinus* sp. (hornbeam) and *Fragula alnus* (alder buckthorn) all making up <0.5% (<100 counts each) of the charcoal assemblage identified **(Figures 4.3.3, 4.3.4).**

Since the percentage of counts and their corresponding weights were equally correlated **(see Chapter 3, Section 3.6.3)**, the “law of fragmentation” is accepted for this dataset and so absolute fragment counts converted to percentage frequency will form the primary quantitative method for all data expressed going forward in this chapter and Chapter 5 (Case Studies).

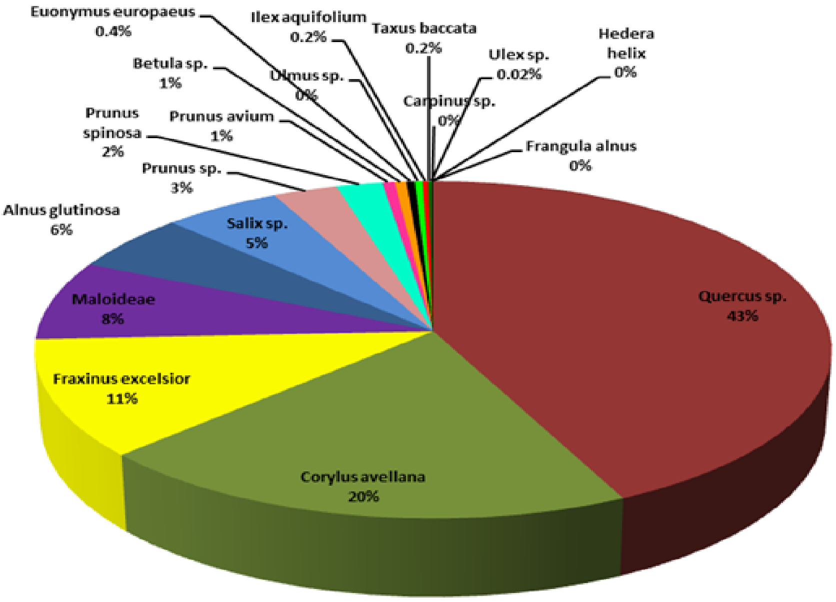


Figure 4.3.3 Percentage of total charcoal identifications (n = 20,953)

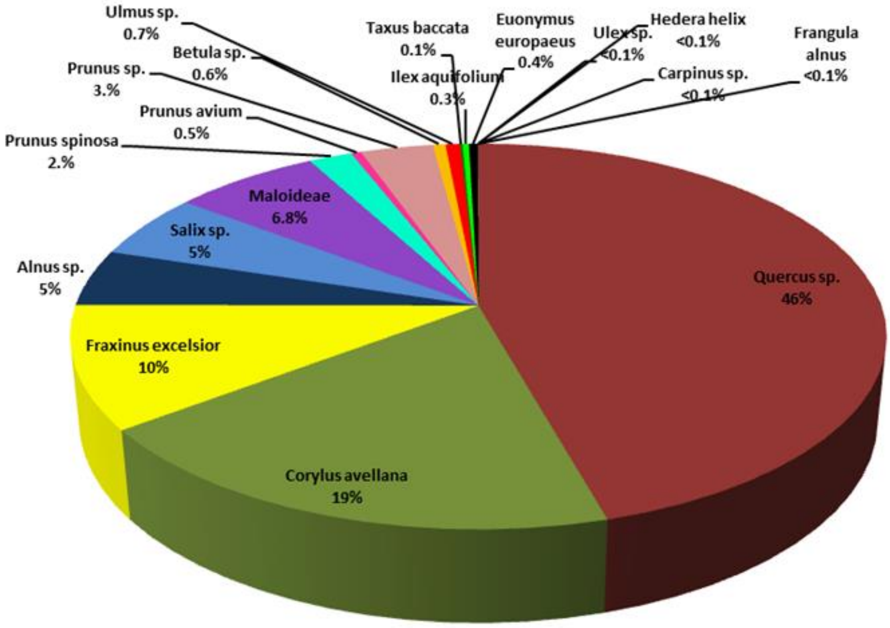


Figure 4.3.4 Percentage of total charcoal identifications (weight = 2891.8g)

4.3.2 Wood charcoal results by region

Nineteen sites from county Tipperary were studied, where 12,345 charcoal fragments from 420 samples were analysed, making up 59% of the overall assemblage. A total of 8,608 charcoal fragments from 244 samples representing 29 sites in Kilkenny were selected for analysis, which accounted for 41% of the identified assemblage **(Table 4.3.3).**

Table 4.3.3 Total number of taxa identified in raw counts and percentage frequency per count

Taxon	Tipperary	% of Total Counts	Kilkenny	% of Total Counts
Quercus sp.	4639	22.0%	4349	20.4%
Corylus avellana	2719	12.9%	1484	7.2%
Fraxinus excelsior	1821	8.6%	544	2.6%
Alnus glutinosa	628	3.0%	528	2.4%
Salix sp.	888	4.2%	228	1.5%
Maloideae spp.	1051	5.0%	552	2.9%
Prunus spinosa	113	0.5%	322	1.6%
Pruus avium	112	0.5%	4	0.0%
Prunus sp.	145	0.7%	463	2.1%
Betula sp.	63	0.3%	47	0.3%
Ulmus sp.	35	0.2%	36	0.1%
Taxus baccata	28	0.1%	10	0.0%
Ilex aquifolium	23	0.1%	31	0.1%
Euonymus europaeus	80	0.4%	0	0.0%
Ulex sp.	0	0.0%	5	0.0%
Hedera helix	0	0.0%	2	0.0%
Carpinus sp.	0	0.0%	2	0.0%
Frangula alnus	0	0.0%	1	0.0%
Total	**12345**	**59%**	**8608**	**41%**

The main observations from the PFA for each study area has revealed that oak is proportionally higher from sites in Kilkenny than from sites in Tipperary. Ash, hazel and Maloideae woods are more widely used in Tipperary, while the *Prunus* species are recorded in higher values from sites in Kilkenny **(Figure 4.3.5).** As the charcoal results are further discussed by site and feature throughout this chapter and beyond, a more comprehensive picture of why these variances exist will become more apparent, which will help to explain these regional disparities in wood resource use.

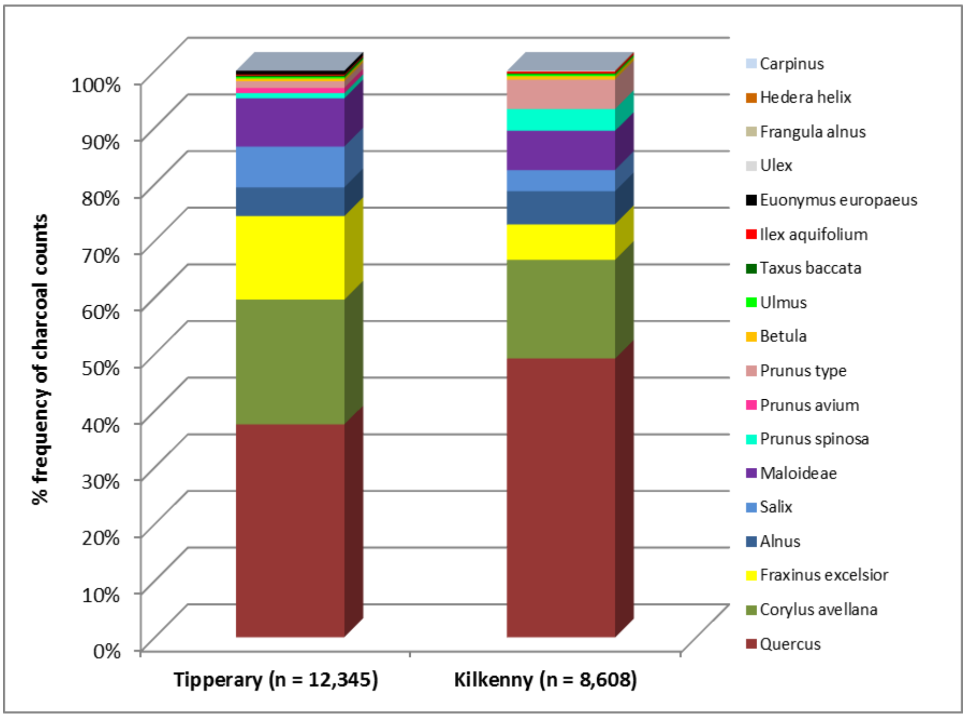


Figure 4.3.5 Distribution of wood taxa from Tipperary and Kilkenny/Carlow (n = 20,953)

4.3.3 Wood charcoal results by period

By graphing the sites chronologically based on the radiocarbon calibrations for each site **(see Appendix 4 for all radiocarbon dates by site),** one major observation from the dataset is the increase in oak values from the early medieval period (fifth – tenth century AD) through to the late medieval period (post-1200 AD), where the percentage of oak rises from 38% to 57%, while values for ash decline from 15% to 1% at the same time **(Figure 4.3.6).** This is especially evident from the tenth century to post-1200 AD dated sites in both regions, such as Borris/Blackcastle (AR31/AR33), Boscabell, Moycarkey and Windmill in Tipperary **(Figure 4.3.7)** and Coolmore, Danesfort (Site 6), Earlsrath, Rahard West, Scart, Scart/Rahard, Shankill and Riceland in Kilkenny **(Figure 4.3.8).**

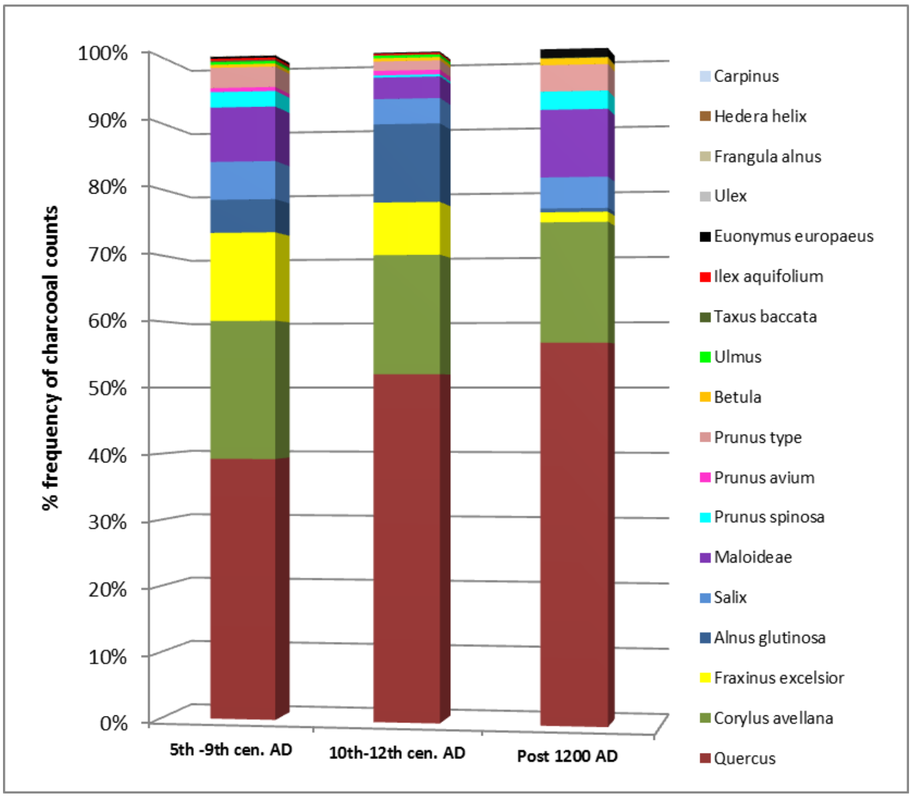


Figure 4.3.6 Distribution of wood taxa chronologically (n = 20,953)

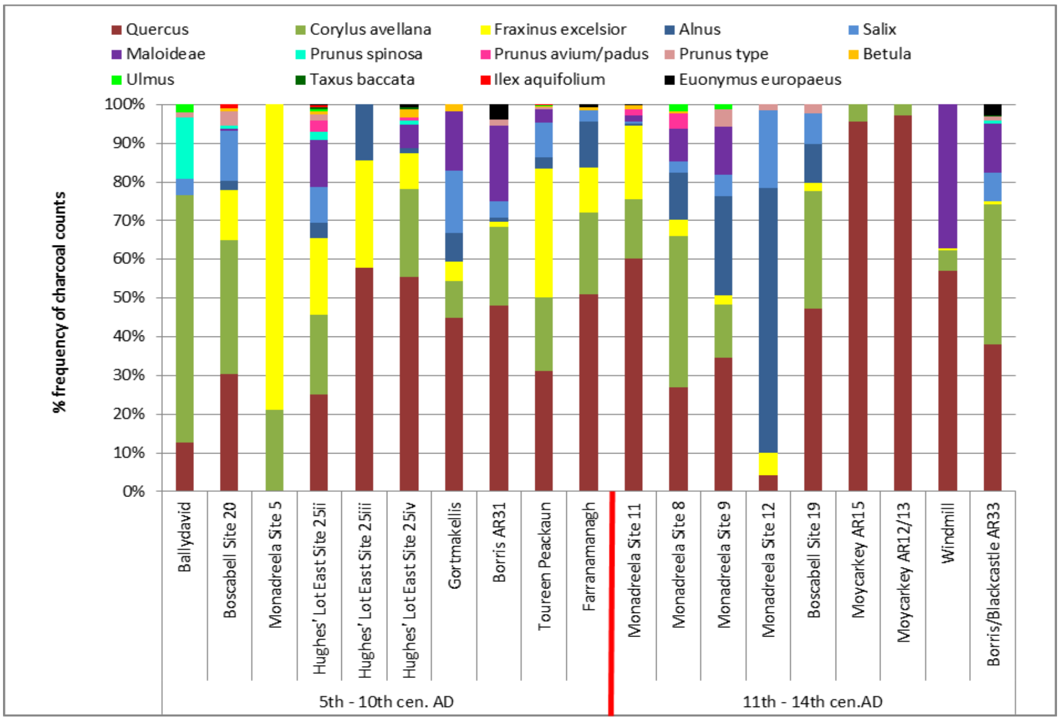


Figure 4.3.7 Distribution of wood taxa from sites in Co. Tipperary (n = 12,345)

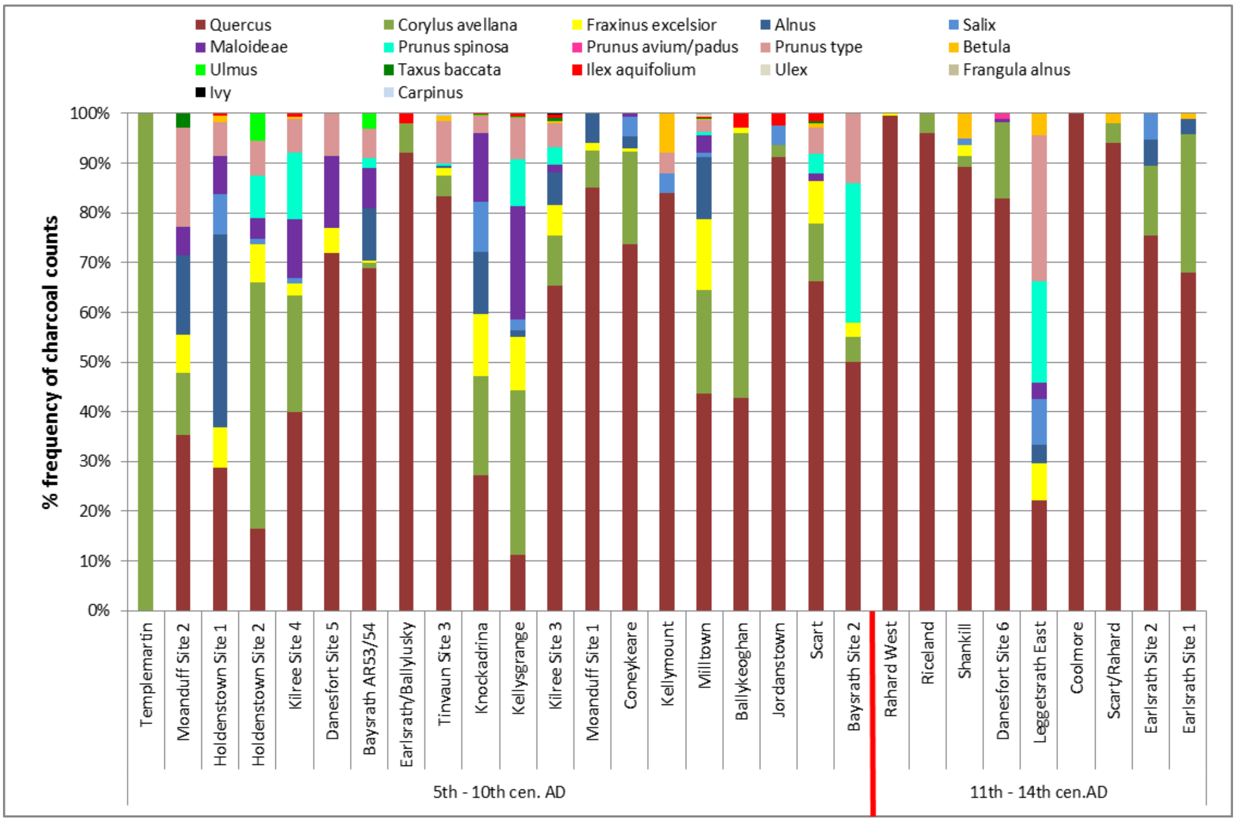


Figure 4.3.8 Distribution of wood taxa from sites in County Kilkenny/Carlow (n = 8,608)

When the dataset is run through Indicator Species Analysis (ISA) details on species consistency and distribution of relative abundance confirms this observation. The indicator value for oak (41.7), with a *p*-value of <0.05 demonstrates that oak is more abundant and constant on sites that date to the later medieval period, particularly those post-1200AD. Conversely, the indicator value for ash (54.9) confirms this taxon to be more consistent with earlier medieval sites, dating from the fifth to the ninth/tenth century AD. In addition, hazel (40.8), alder (42.7), willow (26.2) and the Maloideae wood group (27.4) are all more likely to be found on sites dating from the fifth to the tenth century AD based on their relative abundance and consistency within the dataset **(Table 4.3.4).**

Table 4.3.4 Indicator Species Analysis of wood taxa by period (values in red are strongest indicators >25) **(p = <0.05)**

Taxon	Period	Indicator Value (IV)
Fraxinus excelsior	5th – 10th cen. AD	**54.9**
Corylus avellana	5th – 10th cen. AD	**40.8**
Alnus glutinosa	5th – 10th cen. AD	**42.7**
Salix sp.	5th – 10th cen. AD	**26.2**
Maloideae spp.	5th – 10th cen. AD	**27.4**
Ilex aquifolium	5th – 10th cen. AD	15.8
Prunus avium/padus	10th – 12th cen. AD	20.0
Euonymus europaeus	10th – 12th cen. AD	14.3
Quercus sp.	Post 1200 AD	**41.7**
Prunus spinosa	Post 1200 AD	19.6
Prunus-type	Post 1200 AD	21.3
Betula sp.	Post 1200 AD	20.1

Seed = 5675 **p = 0.06** **No. of counts = 19,338**

To further test if the relative frequency and average abundance of wood taxa is similar between the early and later medieval phases, the data was run through MRPP. The results are based on permutations (identity and abundance of taxa) between the identified wood species and chronological phases.

The MRPP results show that there are some differences between the use of wood in the early medieval period compared to the later medieval period (T = -2.733, P = 0.018, A = 0.045) (negative T-value), with the sample units belonging to each grouping showing less heterogeneity than expected (high A value). When the pairwise comparison values are interpreted **(Table 4.3.5)**, which compares each group to each other, the most obvious difference occurs between the fifth to tenth century AD grouping and the post-1200 AD grouping. This is indicated by the low T and P value (T = -4.415; P = 0.062). The A value (0.003) however demonstrates that, heterogeneity or diversity of wood taxa between the early and later phases is almost equal to that expected by chance. Interestingly, wood taxa is less diverse between the tenth to twelfth century AD sites and the post-1200 AD sites (T = -0.328; A = 0.286 and T = -0.196; A = 0.287), which suggests less variance in wood taxa being used compared to the earlier medieval phase. This would therefore explain the shift to a more oak dominant wood use in the later medieval period and that this change had possibly occurred by or during the c. tenth century AD, when the types of wood used were becoming less diverse overall.

Table 4.3.5 Pairwise comparison (MRPP) for wood taxa by period (significant values in red)

Phase	Test	10th -Late 12th cen. AD	Post 1200AD
5th-10th cen. AD	T	-0.328	**-4.415**
	P	0.004	**0.062**
	A	0.286	**0.003**
10th-Late 12th cen. AD	T	-0.196	
	P	0.007	
	A	0.287	

T = -2.733 P = 0.018 A = 0.045

To investigate any distinct patterns or correlations between the wood taxa themselves from the early and later medieval phases, ordination (NMS) was undertaken. Sites containing less than 100 charcoal counts were omitted from this analysis as they generated a poor NMS resolution. These sites included Hughes' Lot East Site 25iii, Co. Tipperary and Moanduff (Carlow) Kellymount, Scart and Rahard, Earlsrath, Earlsrath/Ballylusky and Riceland in Co. Kilkenny Similarly, four wood taxa were removed from the NMS matrix (*Ulex europaeus, Frangula alnus, Hedera helix* and *Carpinus* sp.) as they contained <5 counts and were not deemed a suitable representation of these wood taxa within the context of this query building analysis.

A total of 41 sites, 657 samples with a combined charcoal count of 20,558 were arranged into a normal response matrix. Multiple runs were preformed using randomized data and a Sørensen distance measure, which produced a ***seed number*** of ***367, final stress*** of ***11.87*** and a ***p-value*** of ***0.004.***

From a two-dimensional solution, the main observations from the ordination scores show that oak is clustered towards phases of activity that date from the tenth to post-1200 AD (Axis 1) **(Figure 4.3.9).** A scatterplot depicting the relative abundance of oak values per site also illustrates this trend where higher abundance clusters towards the tenth to post-1200 AD phase (Axis 1) **(Figure 4.3.10).** In contrast, ash, hazel, willow, cherry, Maloideae, blackthorn, elm and spindle are all positioned on the opposing side of the graph, clustering towards the early medieval phase of activity (fifth to tenth cen. AD).

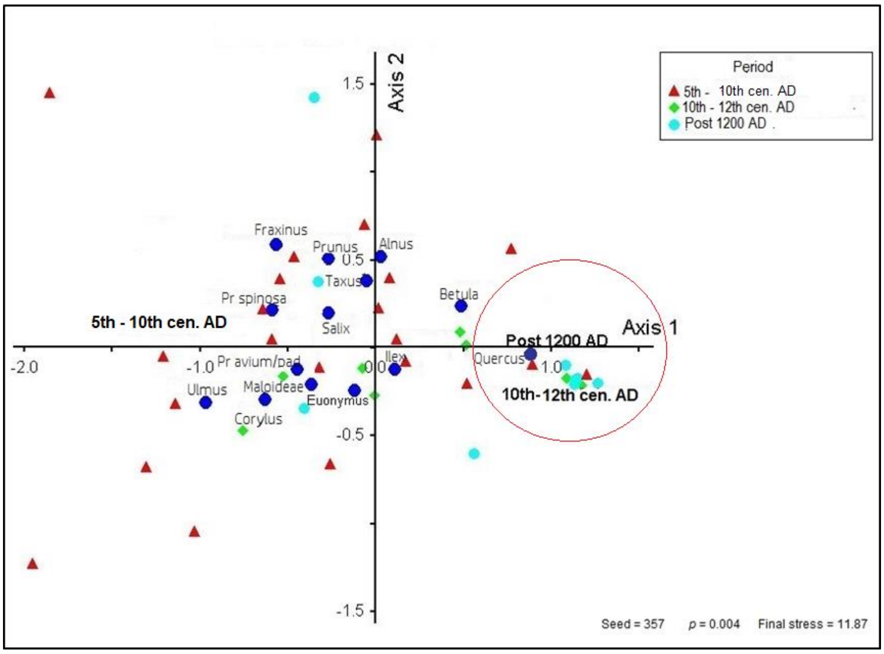


Figure 4.3.9 NMS ordination (Axis 1v 2) of wood taxa from medieval sites by period (n = 20,558; 657 samples)

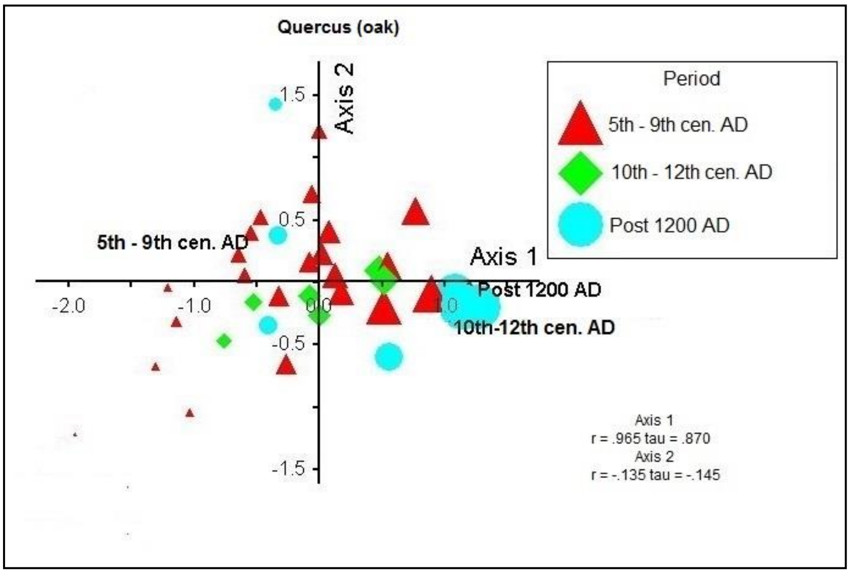


Figure 4.3.10 Scatterplot of NMS ordination for *Quercus*

The Pearson's *r*-value scores on Axis 1 **(Table 4.3.6)** serves to illustrate this, where the high positive oak value (0.965) is opposite to the negative values for many of the aforementioned species, particularly ash, hazel, willow, blackthorn and the Maloideae wood group. Oak therefore has an inverted linear relationship with many other taxa, where it increases in line with other taxa decreasing at the same time.

While this supports the PFA and Indicator Species Analysis, where oak is more strongly correlated to post-tenth century AD sites, it also highlights that oak use or its presence on a site is different to other taxa during the fifth to tenth century AD phase. When oak frequency in high other species collectively, are not. The use of ordination analysis with this dataset has also highlighted that sites dating to between the fifth to tenth century AD contain a more varied composition of wood species. The corresponding scatterplots for individual wood species helps to demonstrate that ash **(Figure 4.3.11)**, hazel **(Figure 4.4.12)** and Maloideae species **(Figure 4.3.13)** for example are more prolific on earlier dated sites. Ash and hazel decline from sites thereafter, while Maloideae use dips during the tenth to twelfth century, rising again in the post-1200AD period.

Table 4.3.6 Correlations (Pearson's *r*-value) of explanatory variables in NMS of wood taxa (Values in red are significant at the $p<0.05$ level for two tailed t-test)

Taxon	Axis 1 *r-value*	Axis 2 *r-value*
Fraxinus excelsior	-0.373	**0.595**
Salix sp.	-0.273	0.305
Quercus sp.	**0.965**	-0.135
Maloideae spp.	-0.288	-0.254
Alnus glutinosa	0.018	**0.504**
Corylus avellana	-0.757	**-0.554**
Prunus spinosa	-0.322	0.182
Prunus avium/padus	-0.152	-0.067
Prunus sp.	-0.181	**0.53**
Betula sp.	0.284	0.211
Ulmus sp.	-0.361	-0.183
Taxus baccata	-0.018	0.205
Euonymus europaeus	-0.039	-0.124
Ilex aquifolium	0.057	-0.1

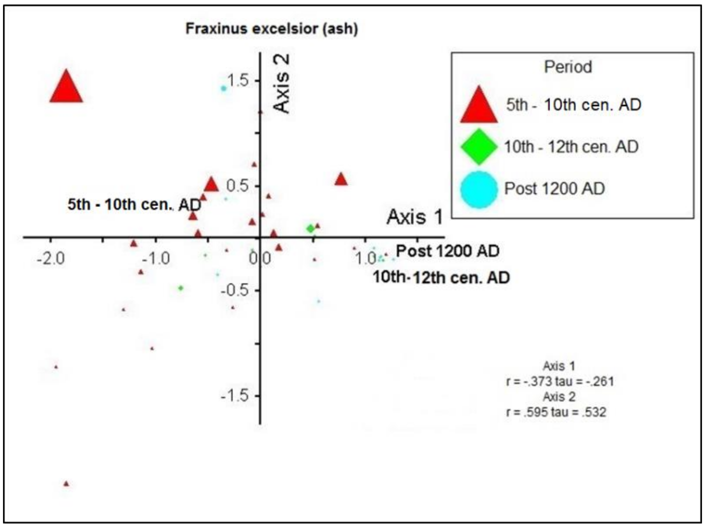


Figure 4.3.11 Scatterplot of NMS ordination for *Fraxinus exceslior*

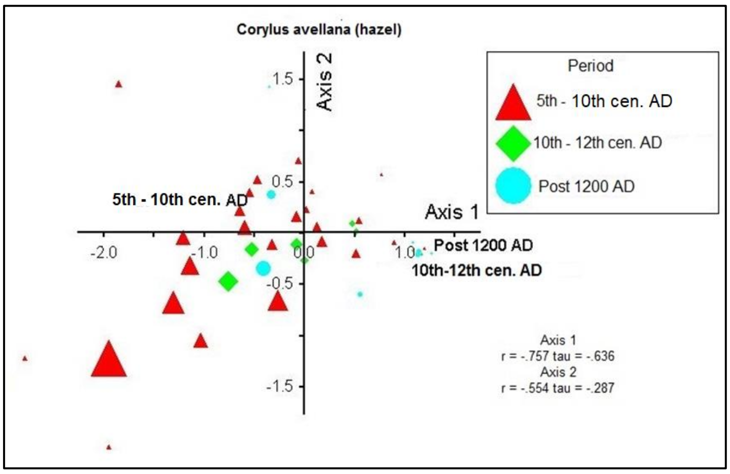


Figure 4.3.12 Scatterplot of NMS ordination for *Corylus avellana*

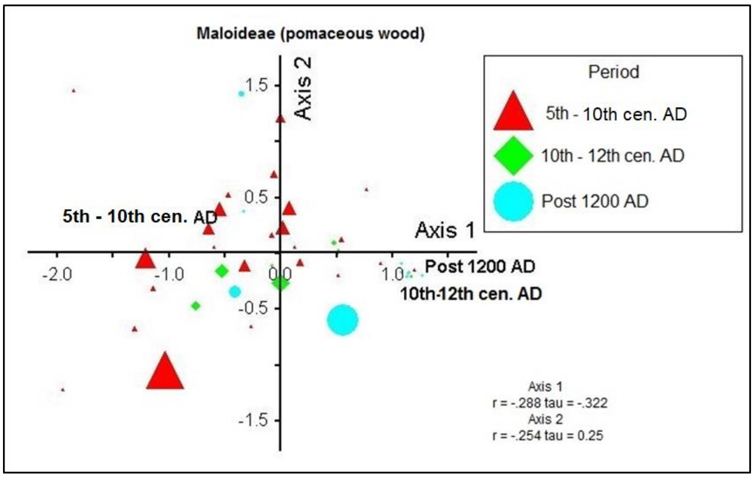


Figure 4.3.13 Scatterplot of NMS ordination for Maloideae species

Other observed results from the ordination scores (Axis 2) **(Table 4.3.6)** reveal that ash, alder, willow and *Prunus* woods are more strongly correlated together, displaying a high positive *r*-value on Axis 2. This is in comparison to the high negative *r*-value for hazel on Axis 2, which indicates that they have an inverted linear relationship - when hazel is decreasing on sites, ash, alder, willow and *Prunus* species are increasing and *vice versa*. The same may be said for oak and Maloideae wood species (negative values on Axis 2). Ordination has not only strengthened the position of oak becoming more widespread from the tenth century, but has shown that wood use between the fifth and tenth centuries fluctuates and was more diverse than previously observed through the PFA analysis. It also highlights the juxtaposition between oak use and other wood taxa during this earlier phase, which raises some interesting questions about the availability and distribution of oak wood resources during the early medieval period. This variability will now be explored in more detail to establish how these explicit patterns of wood use are reflected at feature level.

4.3.4 Wood taxa by feature

A total of 664 samples from 518 features were selected for analysis, representing a cross-section of the typical context-types excavated, recorded and sampled from Irish medieval sites. The highest numbers of these were classified as pits, of which there were 153. The majority of there displayed no scorching or *in situ* burning and as such functionality was difficult to establish. Structural features (postholes/stakeholes) made up 131 of the features and slot trenches 38. Corn drying kilns and ditch features, the latter of which were classified as enclosure, boundary or linear ditches, accounted for 130 and 111 respectively of the total samples analysed. Features clearly distinguished as metalworking pits/charcoal production pits, hearths, souterrains, graves and miscellaneous spread/deposits made up >50 samples each **(Table 4.3.7; Figure 4.3.14).**

Table 4.3.7 Total number of features, samples and charcoal fragment counts analysed

Feature type	No. of features	No. of samples	No. of charcoal identifications	% of total charcoal identifications
Pit	153	153	5147	25%
Posthole/Stakehole	131	131	3141	15%
Corn drying kiln	51	130	4618	22%
Ditch deposits	78	111	3514	17%
Metalworking/Charcoal production	26	34	1239	6%
Slot trench	12	28	753	4%
Hearth	24	24	849	4%
Spread/Deposit	20	20	711	3%
Grave	13	13	450	2%
Souterrain	1	11	286	1%
Unclassified feature	9	9	245	1%
Total	**518**	**664**	**20,953**	**100%**

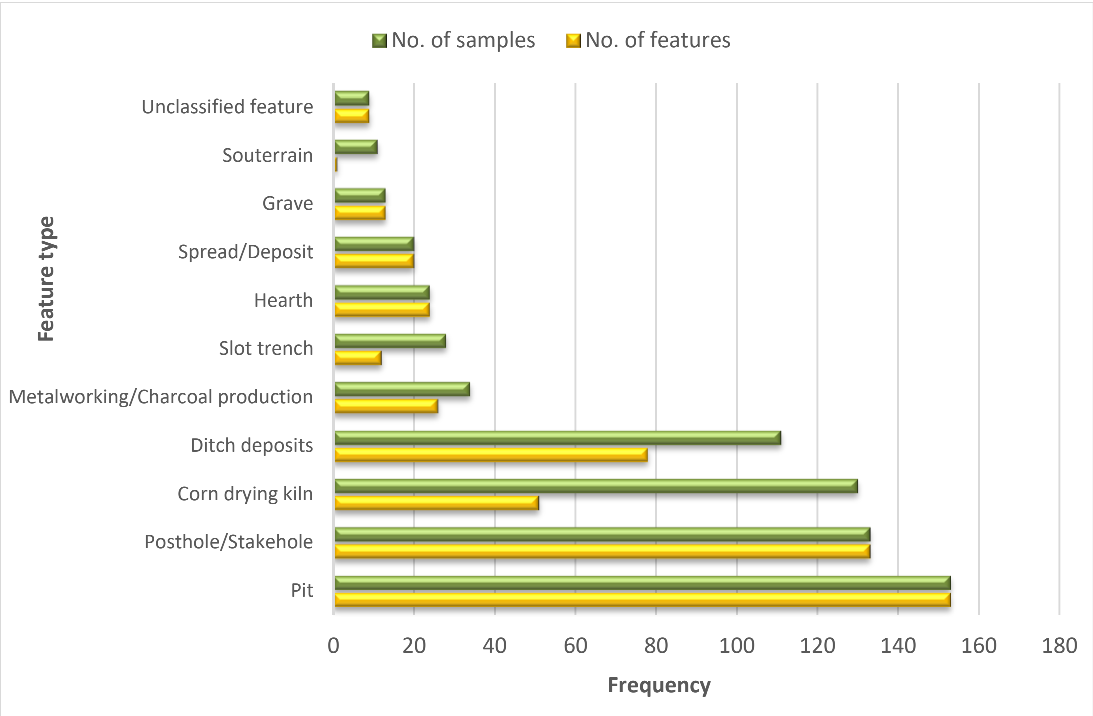


Figure 4.3.14 Total number of samples per feature analysed

Pit features

Wood taxa from pit features (i.e.classified as having no scorching, scorching or partial scorching at the base) were dominated by *Quercus* sp. (49%) and *Corylus avellana* (23%). Much lower occurrences for *Fraxinus excelsior* (9%), *Alnus glutinosa* (6%) Maloideae species (4%) and *Salix* sp. (3%) were recorded. The remaining taxa (*Prunus* sp., *Prunus avium, Prunus spinosa*, *Betula,* sp., *Ulmus* sp., *Ilex aquifolium*, *Ulex europaeus*, *Euonymus europaeus* and *Taxus baccata*) were found in much lower frequencies (<2%) **(Figure 4.3.15).**

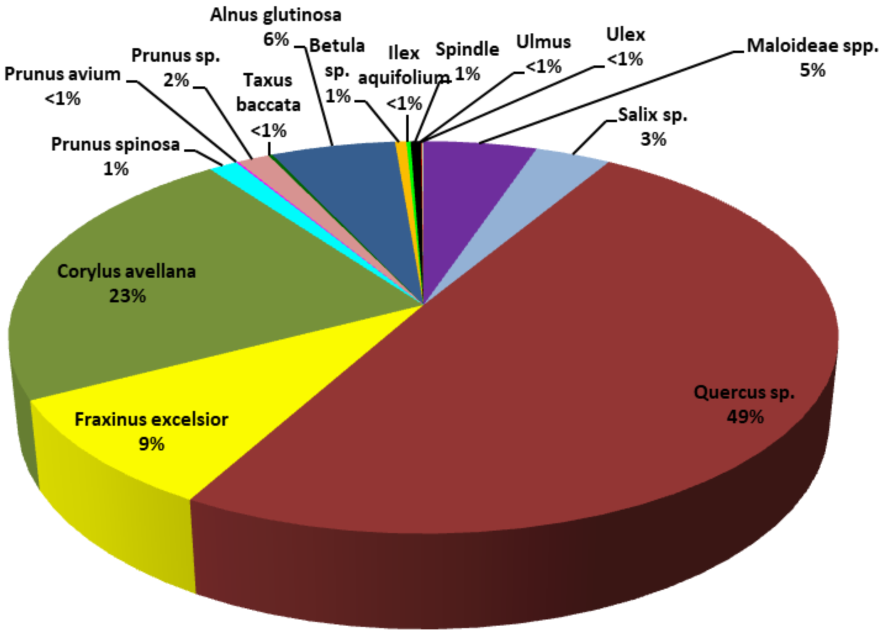


Figure 4.3.15 Percentage of wood taxa from pit features (n = 5,147)

When the distribution of wood taxa is ordered chronologically by site, variability seems at first to be consistent from the early to the later medieval period **(Figure 4.3.16).** On closer inspection and considering the patterns discussed in **Section 4.3.3,** there is some decline in ash values between the early and later medieval periods, at the same time there is an increase in oak. If these two taxa are plotted against each other, this trend becomes more apparent, where ash value decline from pit features dating from the tenth century onwards, while oak remains high and constant **(Figure 4.3.17)**.

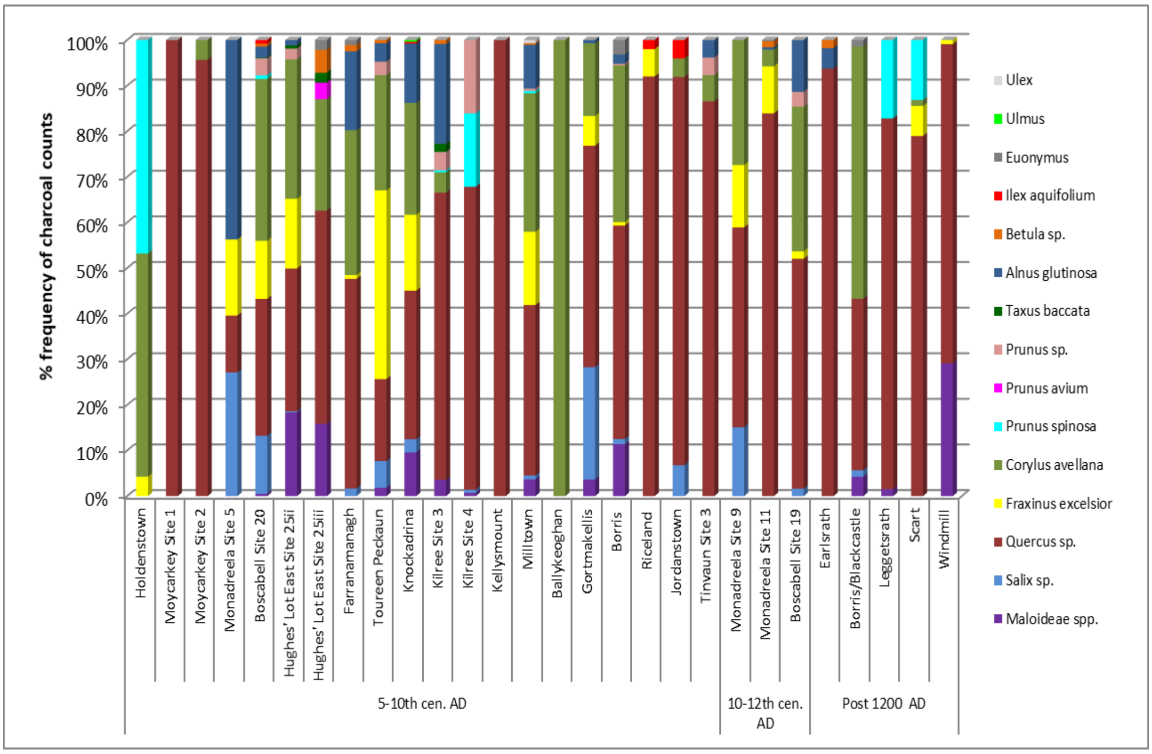


Figure 4.3.16 Distribution of wood taxa from pit features

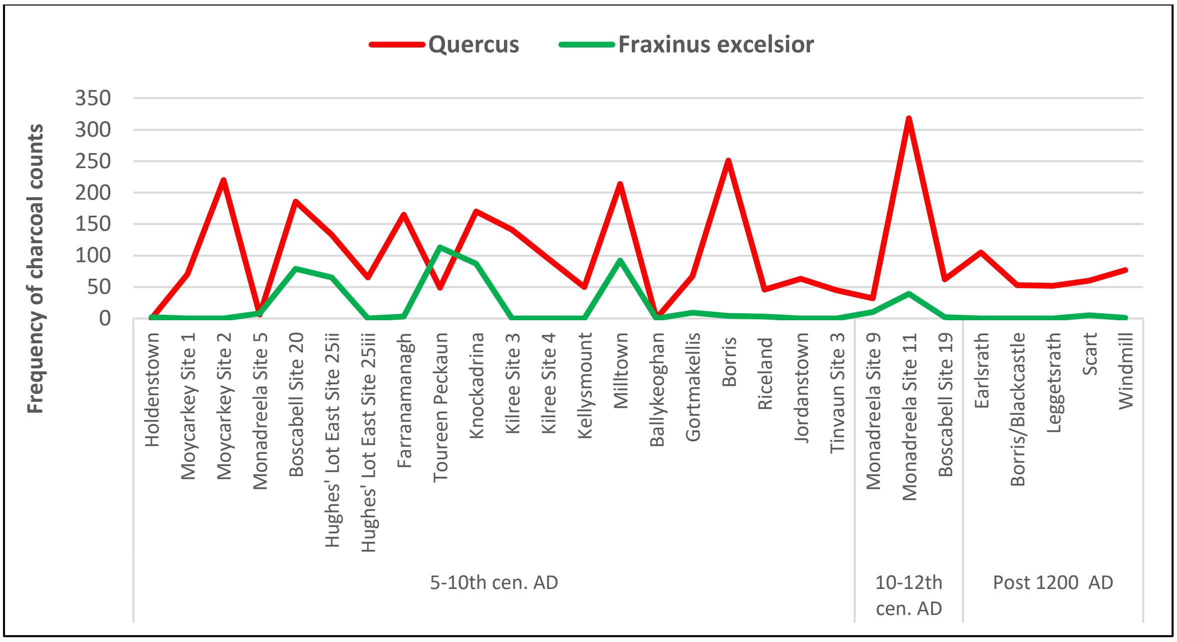


Figure 4.3.17 Comparisons between frequency of *Quercus* (oak) and *Fraxinus* (ash) from pit features (n = 3,317)

This is further supported by ISA, where ash is more correlated to the early medieval period (fifth to tenth cen. AD), while oak is associated with later phases **(Table 4.3.8).** This exercise also highlights the diversity of wood taxa found in pits from the early medieval period, with hazel, willow, Maloideae woods, blackthorn and cherry-type species all correlated with early medieval dated pits. Oak variability during the earlier medieval period is also a feature of this dataset, where sites containing a noticeable high oak content, sees a general absence in ash charcoal (e.g. Moycarkey Sites 1/2, Borris, Kilree Sites 3/4, Kellysmount and Tinvaun Site 3). In contrast, lower oak values are found on sites where there is a higher ash component (e.g. Toureen Peckaun and Monadreela).

Table 4.3.8 Indicator Species Analysis of wood taxa in pits (values in red are strongest indicators >25) (*p* = <0.05)

Taxon	Period	Indicator Value (IV)
Fraxinus excelsior	5th - 10th cen AD	**42.0**
Corylus avellana	5th - 10th cen AD	**37.7**
Salix	5th - 10th cen AD	**30.7**
Maloideae	5th - 10th cen AD	**37.9**
Prunus spinosa	5th - 10th cen AD	**25.2**
Prunus avium	5th - 10th cen AD	8.3
Prunus types	5th - 10th cen AD	**52.9**
Betula	5th - 10th cen AD	20.6
Ilex aquifolium	5th - 10th cen AD	11.7
Euovymus europaeus	5th - 10th cen AD	10.9
Quercus	10th- post-1200 AD	**37.0**
Alnus	10th - post-1200 AD	**35.3**

Seed = 3395 **p = 0.09** **No. of counts 5,651**

Structural features

Wood taxa from structural features (i.e. postholes, stakeholes and slot trenches) were dominated by *Quercus* sp. (48%), *Corylus avellana* (21%) and *Fraxinus excelsior* (16%). *Salix* sp. accounted for 6%, Maloideae species make up 5% and *Alnus glutinosa* 1%. The remaining taxa (*Prunus* sp., *Prunus spinosa*, *Betula*, sp., *Ulmus* sp., *Ilex aquifolium*, *Euonymus europaeus* and *Taxus baccata*) were found in much lower frequencies (<1%) **(Figure 4.3.18).**

Posthole and stakeholes made up the majority of these features accounting for 3,141 charcoal counts. From these, oak made up 41% of the wood taxa assemblage, hazel 23% and ash 22%. Willow accounted for 7%, Maloideae species 4% and all other taxa <1%.

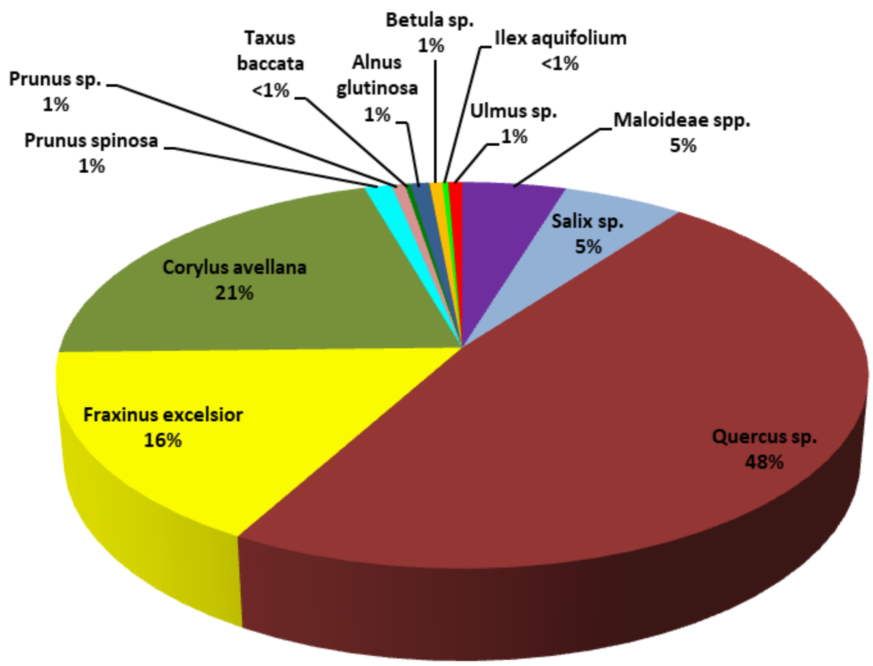


Figure 4.3.18 Percentage of wood taxa from structural features (n = 3,894)

When the distribution of this dataset is viewed by site, the main observations are the varying trends in the dispersal of oak and ash from these features **(Figure 4.3.19),** which is similar to the pit dataset**.** Post and stakeholes from sites dating between fifth and tenth century AD contain more ash charcoal than sites that date to the later period (post-tenth century). Notable ash frequencies are recorded at Hughes' Lot East, Toureen Peckaun, Kellysgrange and Farranamanagh, all sites where lower or absent oak values were identified from post/stakeholes. When oak values are high from post/stakeholes dating to this earlier phase, such as Holdenstown, Danesfort (Site 6), Kilree (Site 3), Coneykeare, Tinvaun and Borris, ash values are much lower or absent. While hazel is found at sites where ash is more notable (e.g. Hughes' Lot East, Kellysgrange, Toureen and Kilree (Site 4), it is the dominant wood found in post/stakeholes from Moanduff and Gortmakellis.

The frequency of willow varies from site to site, however its presence from post/stakeholes at Toureen Peckaun, Knockadrina, Farranamanagh and Coneykeare is interesting as hazel values are proportionally lower at these sites. This could reflect the use of willow as a substitute for hazel in construction works, particularly from fifth to ninth century AD. The Maloideae and *Prunus* wood species are also worth a mention in this context, as both taxa groupings are found almost simultaneously from post/stakehole features at Hughes' Lot East, Knockadrina, Kellysgrange, Kilree (Site 3) and Milltown. While not as well documented as hazel and willow, these species may have been used in light structures, particularly *Prunus spinosa* (blackthorn) in fencing, as previous mentioned **(Chapter 1)** (Kelly 1997, 374).

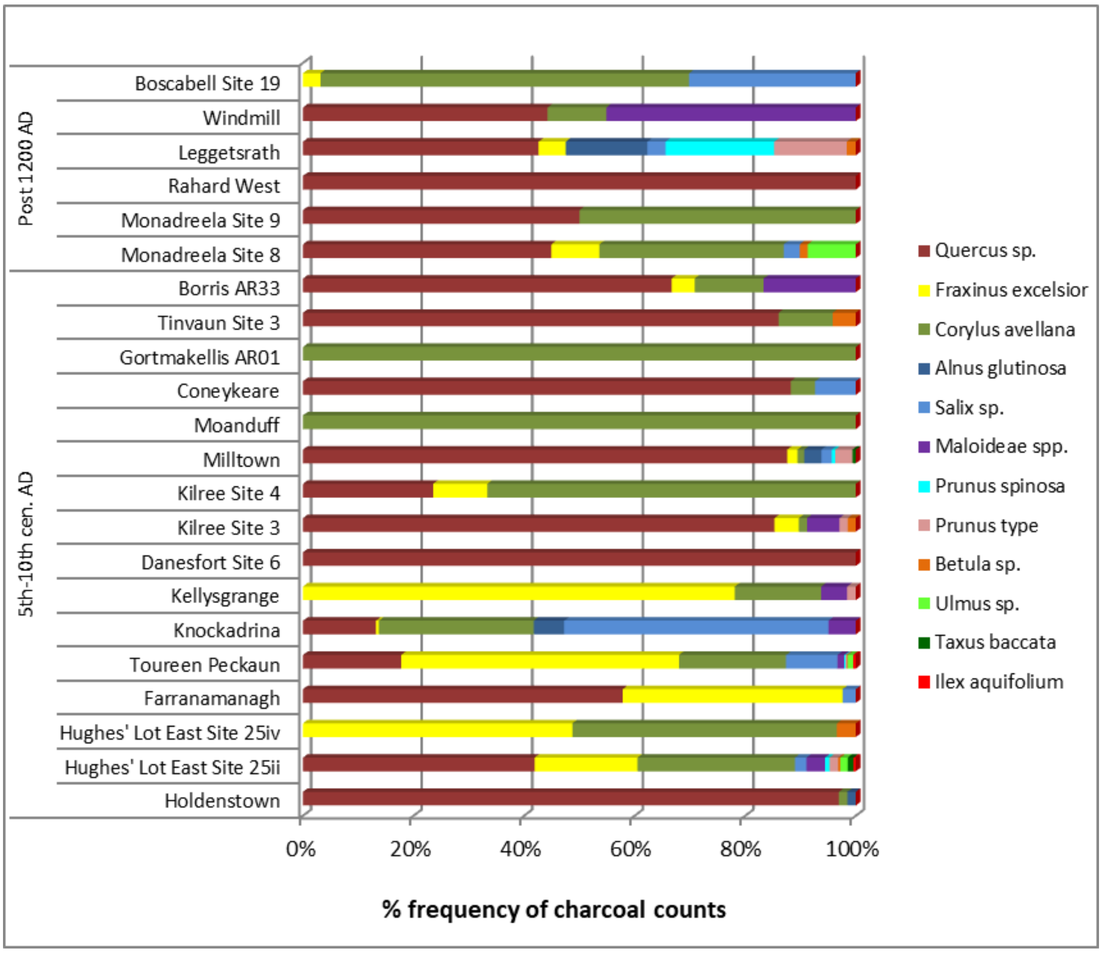


Figure 4.3.19 Distribution of wood taxa from post/stakehole features (n = 3,141)

Ash sees a marked decline in post/stakeholes from sites dating to the post-tenth century and later, while oak values remain high or constant at the same time, a trend that is noted from Borris (AR33), Monadreela, Rahard West and Windmill. When the oak and ash values are plotted against each other, this trend becomes more apparent, where ash value decline from post/stakeholes dating from the tenth century onwards, while oak remains high **(Figure 4.3.20).** Hazel also remains a feature of post/stakehole charcoal assemblages with those at Mondareela (Sites 8 and 9), Gortmakellis, Boscabell (Site 19) and Moanduff containing a high frequency of this taxa. Maloideae and *Prunus* woods are also slightly higher from post/stakehole deposits at Borris (AR33), Leggetsrath East and Windmill, while alder and elm, both under-represented in earlier sites, were more prominent at Leggetsrath East and Monadreela.

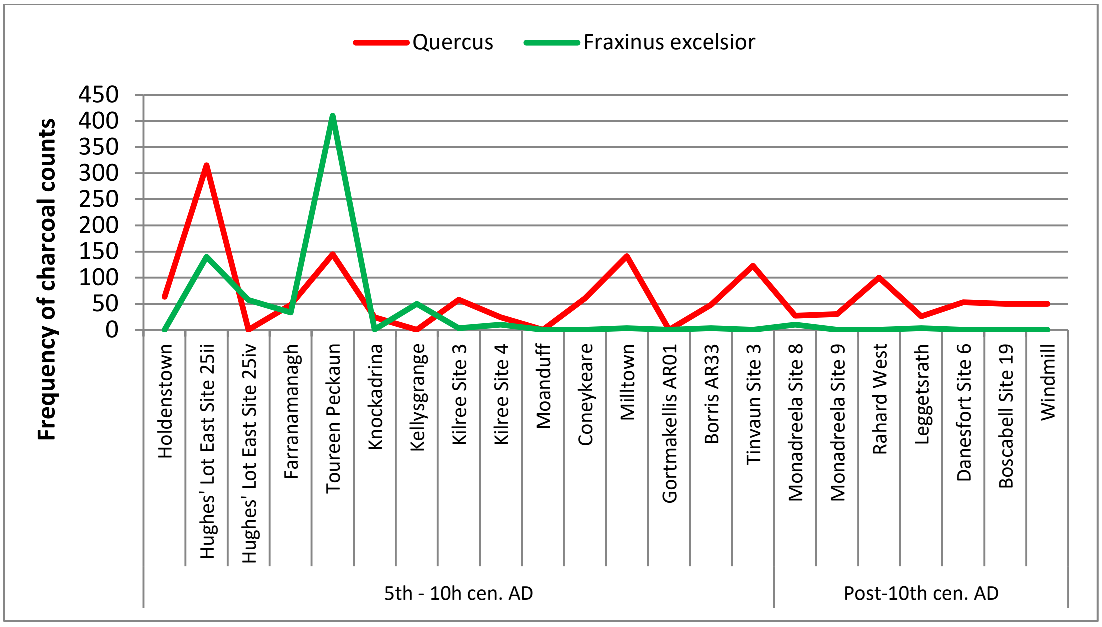


Figure 4.3.20 Comparisons between frequency of *Quercus* (oak) and *Fraxinus* (ash) from post/stakeholes (n = 3,141)

The charcoal assemblage from slot trench features, is however slightly different in composition. While oak still dominates (59%), ash and hazel are lower at 11% each and willow drops to 2.5% **(Figure 4.3.21).** The rise in Maloideae species (9%) and blackthorn (4%) is made more obvious as they dominated the charcoal assemblage from a slot trench at Hughes' Lot East and Leggetsrath East.

The distribution of these taxa is interesting, as the slot trenches with the highest oak are found on fifth to tenth century dated sites where oak is also present in notable frequencies from post/stakeholes at Knockadrina, Kilree (Site 3), Danesfort (Site 6) and Borris (AR33) **(Figure 4.3.22).** With respect to Toureen Peckaun and Kilree (Site 4), where ash and hazel values were high in post/stakehole features, oak seems to be the wood of choice for heavier constructions, reflected in the slot trench charcoal assemblage. In contrast, ash is the preferred wood at Farranamanagh for slot construction, despite both oak and ash dominating post/stakehole deposits. The exception here is Hughes' Lot East, where Maloideae woods dominate the slot trench deposits recorded from this site. While oak and ash are both recorded from the post/stakeholes at Hughes' Lot East, oak overall is relatively low when compared to ash and hazel and could signify that oak is just not available at the site for these heavier construction works

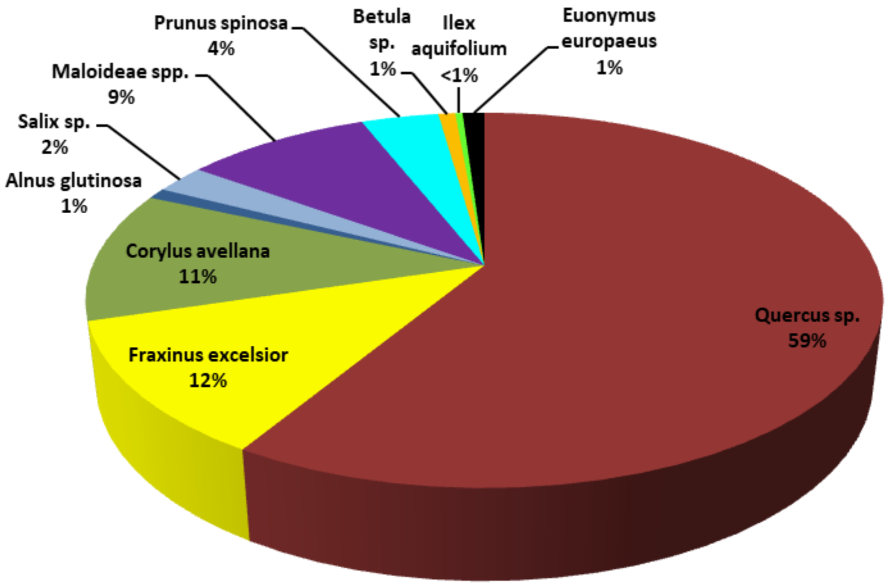


Figure 4.3.21 Percentage of wood taxa from slot trench features (n = 753)

Interestingly, the presence of oak in slot trenches from later dated sites, such as Monadreela (Sites 9 and 11), Leggetsrath East and Borris/Blackcastle (AR31) is surprisingly lower and instead a more mixed wood assemblage is noted. The charcoal fragments from these deposits were lower overall which may skew the picture presented, however considering that oak is found in post/stakeholes from these later medieval sites, it seems perhaps there may be a shift in how oak is being used in construction works during the later medieval period.

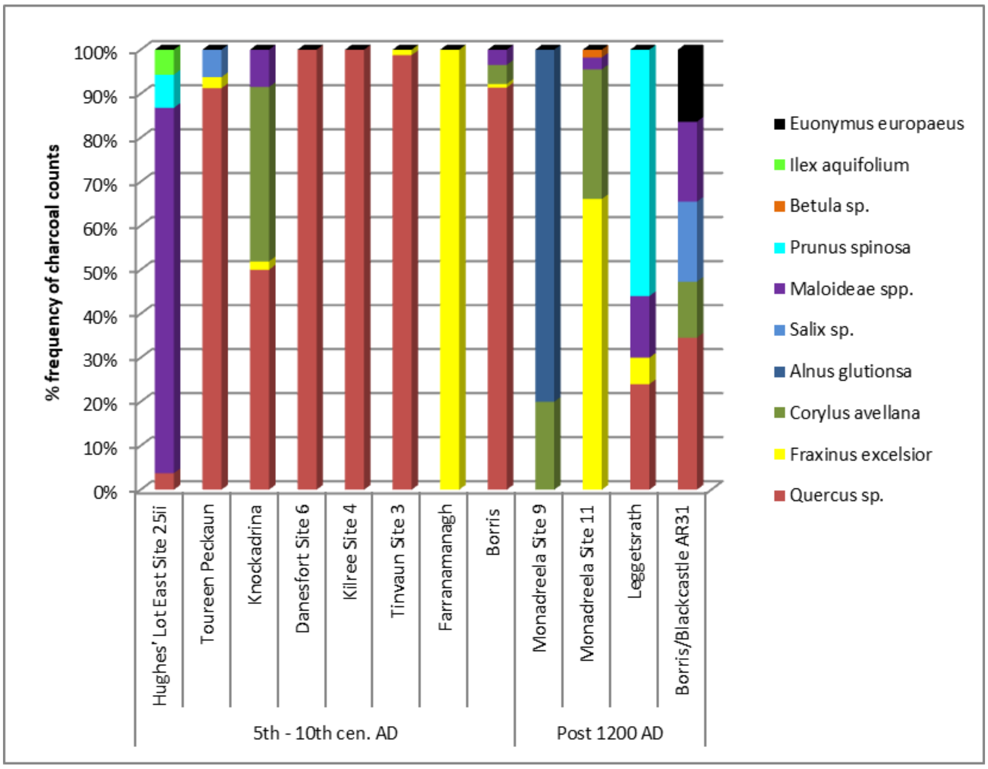


Figure 4.3.22 Distribution of wood taxa from slot trench features

To ascertain how the different wood taxa correlates to each other within structural deposits, Spearman's rank correlations were run on all the fragment counts from the 23 sites that contained post/stakeholes and slot trench features. The first notable aspect within the correlations is that oak, the most significant taxa from many of these sites, is poorly correlated with all other taxa **(Table 4.3.9).**

Based on the frequency of charcoal counts, the strongest correlation values are with hazel, suggesting that oak and hazel are more likely to be found together in these features, but that oak is not well represented when other taxa are present. This would therefore support the use of oak over ash and vice versa in structural deposits, as both are more poorly correlated together they seem unlikely to be found at the same time within this set of features. Hazel on the other hand is strongly correlation with ash, willow and Maloideae wood species, indicating that all four of these taxa are more likely found together in structural features, reflecting contemporary use. The corresponding *Sig(2-tailed)* values representing the *p-value* for these taxa is also high, demonstrating that there are correlation difference in how and when these wood species are being used. Correlations also exist between some of the other wood taxa however the low fragment counts and low *p*-values for these make any interpretations tentative.

Table 4.3.9 Spearman's Correlation Co-efficient values for wood taxa from structural features (values in red show strongest correlations)

Taxon	Co-efficient values	*Quercus*	*Corylus avellana*	*Fraxinus excelsior*	*Alnus glutinosa*	*Salix*	*Maloideae*	*Prunus spinosa*	*Prunus* type	*Betula*	*Ulmus*	*Taxus baccata*	*Ilex aquifolium*
Quercus	Correlation co-efficient	**1**											
	Sig.(2-tailed)	**-**											
	N	**23**											
Corylus avellana	Correlation co-efficient	**0.61**	1										
	Sig.(2-tailed)	**0.02**	-										
	N	**23**	23										
Fraxinus excelsior	Correlation co-efficient	0.48	**0.70**	1									
	Sig.(2-tailed)	0.07	**0.46**	-									
	N	23	**23**	23									
Alnus glutinosa	Correlation co-efficient	0.02	0.12	-0.13	1								
	Sig.(2-tailed)	0.0004	0.003	0.03	-								
	N	23	23	23	23								
Salix	Correlation co-efficient	0.3	**0.6**	**0.6**	0.45	1							
	Sig.(2-tailed)	0.001	**0.03**	**0.13**	0.04	-							
	N	23	**23**	**23**	23	23							
Maloideae	Correlation co-efficient	0.5	**0.61**	0.23	- 0.004	0.2	1						
	Sig.(2-tailed)	0.001	**0.17**	0.10	0.04	0.37	-						
	N	23	**23**	23	23	23	23						
Prunus spinosa	Correlation co-efficient	0.6	**0.7**	0.23	1.7	0.04	**0.72**	1					
	Sig.(2-tailed)	0.0004	**0.003**	0.047	0.09	0.03	**0.02**	-					
	N	23	**23**	23	23	23	**23**	23					
Prunus type	Correlation co-efficient	0.42	0.5	0.2	0.2	0.03	0.48	**0.76**	1				
	Sig.(2-tailed)	0.0004	0.004	0.337	0.294	0.050	0.046	**0.034**	-				
	N	23	23	23	23	23	23	**23**	23				
Betula	Correlation co-efficient	0.38	0.2	0.12	-0.2	-0.07	0.06	0.2	-0.09	1			
	Sig.(2-tailed)	0.0004	0.003	0.05	0.5	0.04	0.04	0.03	0.3	-			
	N	23	23	23	23	23	23	23	23	23			
Ulmus	Correlation co-efficient	0.6	0.8	0.72	-0.14	0.4	0.54	**0.67**	0.5	0.18	1		
	Sig.(2-tailed)	0.0004	0.003	0.051	0.5	0.041	0.036	**0.095**	0.296	0.05	-		
	N	23	23	23	23	23	23	**23**	23	23	23		
Taxus baccata	Correlation co-efficient	0.6	**0.70**	0.25	-0.04	0.05	**0.7**	**0.9**	**0.74**	0.22	**0.7**	1	
	Sig.(2-tailed)	0.0004	**0.004**	0.48	0.17	0.03	**0.02**	**0.33**	**0.070**	0.10	**0.17**	-	
	N	23	**23**	23	23	23	**23**	**23**	**23**	23	**23**	23	
Ilex aquifolium	Correlation co-efficient	0.7	0.9	**0.75**	-0.11	0.41	**0.67**	**0.8**	**0.63**	0.2	**0.9**	**0.8**	1
	Sig.(2-tailed)	0.0004	0.004	**0.05**	0.18	0.03	**0.02**	**0.27**	**0.07**	0.11	**0.18**	**0.46**	-
	N	23	23	**23**	23	23	**23**	**23**	**23**	23	**23**	**23**	23

Ditch features

Wood taxa from ditch features (i.e. enclosure and boundary ditches) contained a much more varied composition of species, but quiet distinct from those found in structures, pit features and corn drying kilns, which will be discussed next. *Quercus* sp. dominated overall (30 %), followed by *Alnus glutinosa* (16%). Equal quantities of *Salix* sp. and Maloideae species (12%) and *Corylus avellana* and *Fraxinus excelsior* (10%) were identified, with *Prunus spinosa* and indeterminate *Prunus* species accounting for 3% and 4% respectively. *Prunus avium/padus*, *Betula* sp., *Ulmus* sp., *Taxus baccata*, *Ilex aquifolium* and *Euonymus europaeus* were also present but recorded in much lower frequencies (<1%) **(Figure 4.3.23).**

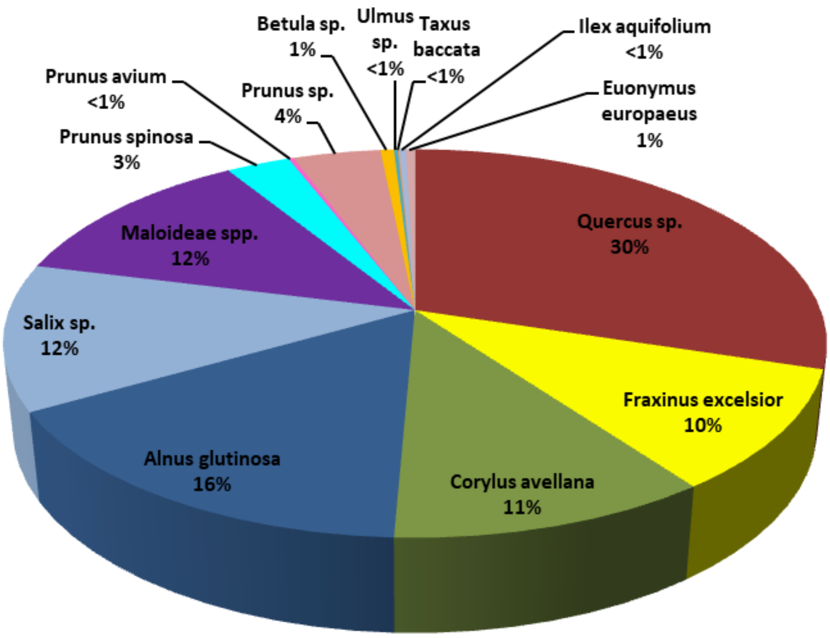


Figure 4.3.23 Percentage of wood taxa from ditch features (n = 3,514)

The main observation of the charcoal dataset from medieval ditch features was the high frequency of alder and willow, both taxa that are generally under-represented from all other features in this study. When the results are plotted together by site, the frequency of alder and willow becomes more apparent, being prevalent on sites that date to both the early medieval (fifth to tenth century AD) and on later medieval sites. These species collectively account for between 5% and 45% of ditch charcoal assemblages on sites such as Holdenstown, Hughes' Lot East, Toureen, Borris (AR33), Farranamanagh, Knockadrina, Monadreela (Site 8) and Borris/Blackcastle

(AR31). Willow made up 90% of the charcoal from a seventh to ninth century ditch at Tinvaun (Site 3), while at Monadreela the thirteenth century ditch recorded on Site 12 contained exclusively alder and willow **(Figure 4.3.24).**

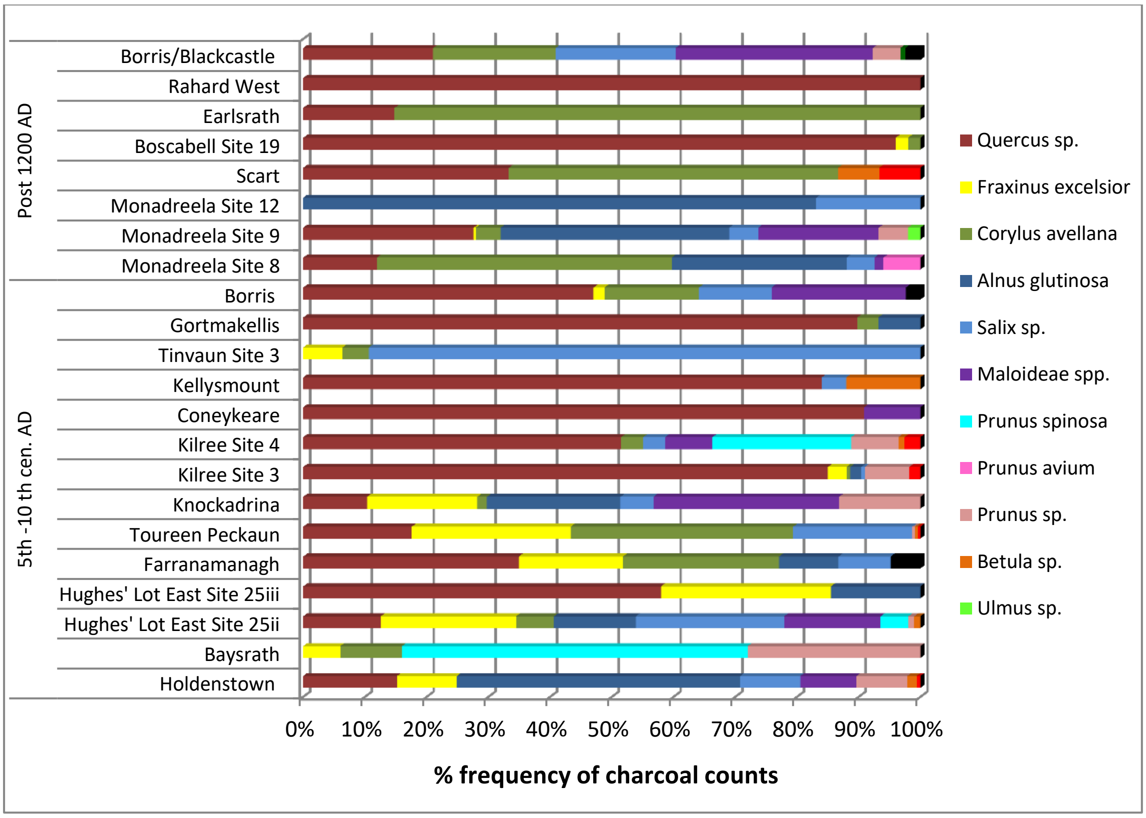


Figure 4.3.24 Distribution of wood taxa from ditch features (n = 3,514)

Maloideae and *Prunus* woods are also significant components of the charcoal cache from these features, accounting for between 10% and 30% of the charcoal assemblage. They co-occur more frequently from sites dating to between the fifth to tenth century, such as Holdenstown, Baysrath, Hughes' Lot East, Borris (AR33), Coneykeare, Knockadrina and Kilree. The thirteenth century settlement at Mondareela and the thirteenth–fifteenth century complex at Borris/Blackcastle (AR31) also contained a notable frequency of these wood taxa. Values for blackthorn were particularly high from Baysrath, Hughes' Lot East and Kilree (Site 4), all sites dating to between the fifth and tenth century AD. Compared to other medieval features analysed, birch and holly were more distinctive in ditch deposits, especially from early medieval sites at Holdenstown, Hughes' Lot East, Toureen, Kilree, Kellysmount and the later eleventh/twelfth century AD site at Scart.

Attention is drawn again to the higher ash values from ditch features dating the fifth to tenth century – Holdenstown, Baysrath, Hughes' Lot East, Toureen, Knockadrina and Tinvaun – compared to those from later medieval sites (e.g. Monadreela, Scart, Boscabell, Earlsrath, Rahard West and Borris/Blackcastle AR31). The pattern of a dominant oak is also present from this phase, with sites such as Kilree, Coneykeare, Kellysmount, Borris and Gortmakellis showing a much lower or absence of ash when oak values are highest. This supports the trend being recorded from the pit, and structural evidence, further highlighting the diverse wood taxa from sites dating to between the fifth and tenth century, interspersed with periods of high and low oak and ash use.

This may go some way to explain how and when oak and ash are being used more broadly at a site – when oak is more available or plentiful, its dispersal is dominant through other features on site, but with ash a more diverse range of wood taxa is more often being found. In a similar trend noted from the pit and structural feature datasets, ash sees a marked decline in ditches from sites dating from the tenth century and later - Monadreela, Scart, Boscabell, Earlsrath, Rahard West and Borris/Blackcastle AR31. When the oak and ash values are plotted against each other, this trend becomes more apparent, where oak remains high and constant from the tenth century onwards **(Figure 4.3.25).**

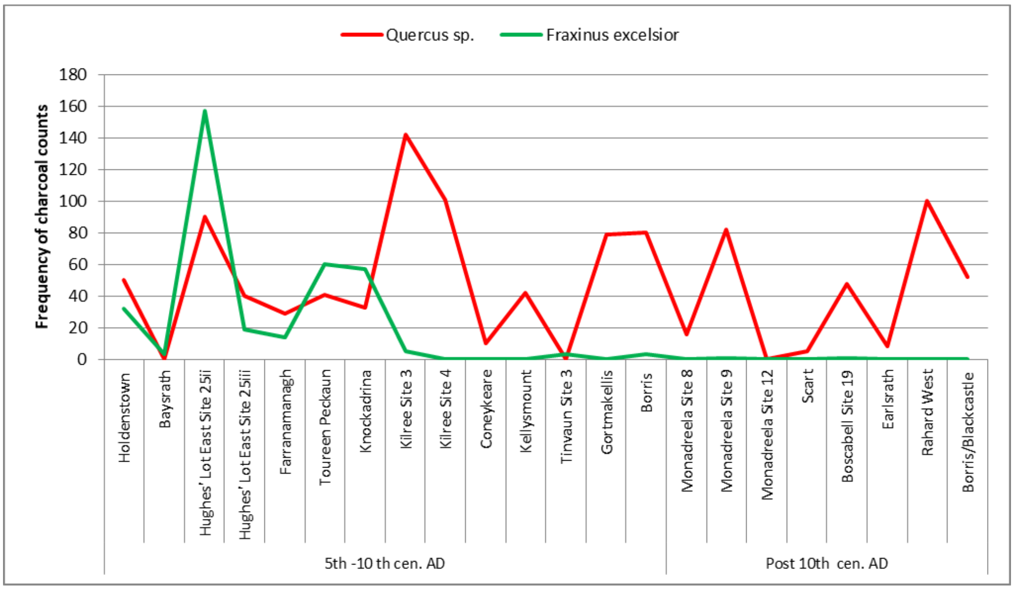


Figure 4.3.25 Comparisons between frequency of *Quercus* (oak) and *Fraxinus* (ash) from ditches (n = 1,426)

Hazel is found throughout, although low frequencies or notable absences are recorded from the seventh/eighth century enclosure ditches at Hughes' Lot East (Site 25ii), Kilree (Site 3), Coneykeare, Kellysmount; a ninth century enclosure ditch at Gortmakellis, and from the twelfth century sites at Monadreela (Site 12), Boscabell (Site 19) and thirteenth/fourteenth century ditch features at Rahard West.

When observing the correlation values for each taxon within ditch features oak is once again poorly correlated with all other wood species, implying that its occurrence is distinct from when or how other species are present **(Table 4.3.10).** Surprisingly, hazel too is poorly correlated to all other taxa in ditch deposits, with the exception of perhaps ash, suggesting therefore that oak and hazel while both found in these features, are not well represented together nor with other taxa. This poses the question then whether oak and hazel are mutually exclusive, representing separate phases of use associated with activities either directly linked to the function of a ditch or other site activities reflected through periods of deposition within these ditch features.

Co-occurring with each other more regularly in ditches are ash, alder, willow and Maloideae wood species. Their relative frequency and abundance from these features implies that they are most probably being used in a similar way or at the same time. To emphasise the previous observation above, alder and willow are strongly correlated within ditch features, compared to the other features analysed as part of this thesis. Since ditches are strongly correlated to the wood variance depicted through structural deposits and corn drying kilns, then they are potentially good indicators of on-site wood use and the fluctuating patterns of wood change local to a site.

Table 4.3.10 Spearman's Correlation Co-efficient values for wood taxa from ditch features (values in red show strongest correlations)

Taxon	**Co-efficient values**	***Quercus* sp.**	***Corylus avellana***	***Fraxinus excelsior***	***Alnus glutinosa***	***Salix* sp.**	***Maloideae* spp.**	***Prunus spinosa***	***Prunus* sp.**	***Betula* sp.**	***Ilex aquifolium***	***Euonymus europaeus***
Quercus sp.	Correlation co-efficient	1										
	Sig.(2-tailed)	-										
	N	17										
Corylus avellana	Correlation co-efficient	-0.005	1									
	Sig.(2-tailed)	0.004	-									
	N	17	17									
Fraxinus excelsior	Correlation co-efficient	0.2	**0.5**	1								
	Sig.(2-tailed)	0.33	**0.3**	-								
	N	17	**17**	17								
Alnus glutinosa	Correlation co-efficient	0.2	0.03	**0.7**	1							
	Sig.(2-tailed)	0.05	0.293	**0.47**	-							
	N	17	17	**17**	17							
Salix sp.	Correlation co-efficient	0.22	0.5	**0.9**	**0.6**							
	Sig.(2-tailed)	0.033	0.322	**0.48**	**0.46**	1						
	N	17	17	**17**	**17**							
Maloideae spp.	Correlation co-efficient	0.25	0.17	**0.8**	**0.7**	**0.7**	1					
	Sig.(2-tailed)	0.013	0.41	**0.39**	**0.37**	**0.405**	-					
	N	17	17	**17**	**17**	**17**	17					
Prunus spinosa	Correlation co-efficient	0.3	0.06	0.3	0.2	0.4	0.3	1				
	Sig.(2-tailed)	0.0003	0.096	0.084	0.1	0.1	0.119	-				
	N	17	17	17	17	17	17	17				
Prunus sp.	Correlation co-efficient	0.14	-0.2	0.27	**0.59**	0.07	**0.6**	0.2	1			
	Sig.(2-tailed)	0.0004	0.111	0.093	**0.109**	0.111	**0.133**	0.427	-			
	N	17	17	17	**17**	17	**17**	17	17			
Betula sp.	Correlation co-efficient	0.23	0.09	**0.6**	**0.6**	**0.6**	0.5	0.34	0.14	1		
	Sig.(2-tailed)	0.0001	0.014	**0.031**	**0.044**	**0.04**	0.039	0.088	0.036	-		
	N	17	17	**17**	**17**	**17**	17	17	17	17		
Ilex aquifolium	Correlation co-efficient	0.6	-0.09	-0.12	0.05	-0.2	-0.09	0.5	0.3	0.1	1	
	Sig.(2-tailed)	0.0001	0.011	0.027	0.04	0.036	0.034	0.088	0.109	0.19	-	
	N	17	17	17	17	17	17	17	17	17	17	
Euonymus europaeus	Correlation co-efficient	0.07	0.14	-0.1	-0.14	-0.06	0.01	-0.17	-0.2	-0.2	-0.19	1
	Sig.(2-tailed)	0.0001	0.010	0.026	0.039	0.034	0.032	0.057	0.020	0.109	0.309	-
	N	17	17	17	17	17	17	17	17	17	17	17

Corn drying kilns

A total of 4,618 charcoal fragments from 130 samples representing 51 corn drying kilns were analysed as part of this study. *Quercus* sp. was the dominant taxa recorded, accounting for 32% (1547 counts) of the overall assemblage, followed by *Corylus avellana*, which made up 28% 1,244 counts). Maloideae species represented 13% (573 counts) of the charcoal assemblage, while ash made up 11% (490 counts). The *Prunus* species were subdivided into *Prunus* sp., *Prunus spinosa* and *Prunus avium* which made up 3% (152 counts), 4% (194 counts) and 3% (120 counts) respectively of the overall kiln charcoal. *Salix* sp. accounted for just 3% (140 counts), *Euonymus europaeus* 1% (51 counts) and *Alnus glutinosa* 0.8% (38 counts). *Betula* sp., *Taxus baccata*, *Ilex aquifolium*, *Ulmus* sp. and *Frangula alnus* (alder buckthorn) all made up >1% (<40 counts) of the kiln assemblage **(Figure 4.3.26).**

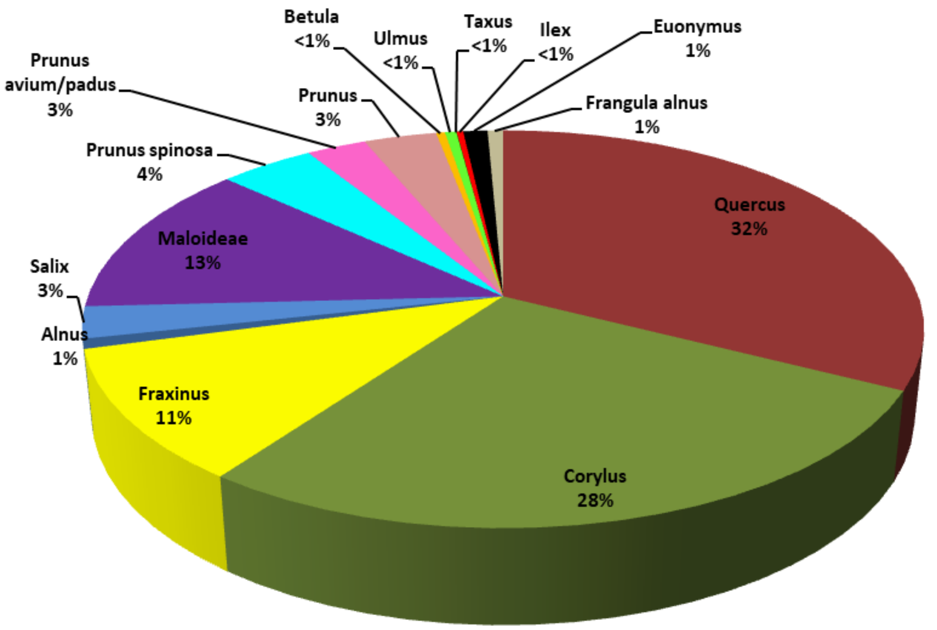


Figure 4.3.26 Percentage of wood taxa from corn drying kilns (n = 4,618)

The corn drying kilns were comparatively rich in taxa although variation in dominant types was evident from kilns in Tipperary and Kilkenny. Observing the results using PFA **(Figure 4.3.27)** and ISA **(Table 4.3.11)**, oak, hazel, ash, the Maloideae wood group and the *Prunus* wood groups were represented most frequently from kilns in both locations. The corn drying kilns from Kilkenny however contained higher oak and *Prunus* values than those in Tipperary, while ash was found proportionally higher from kilns in Tipperary. Although kilns make up approx. 20% of the overall charcoal counts from this study, it is interesting that the distribution of wood taxa recorded from both locations mirrors the trend being identified more broadly **(Section 4.3.2)** from the other features in this study.

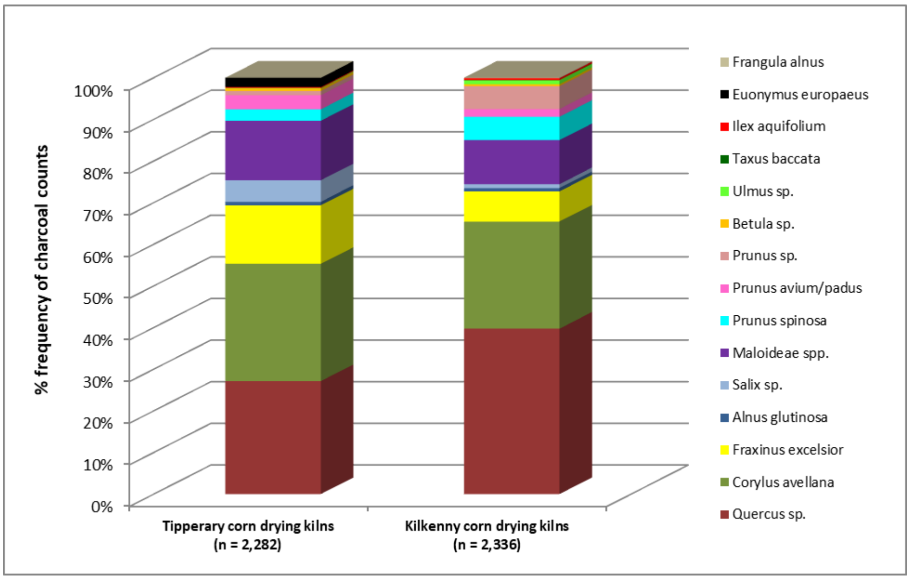


Figure 4.3.27 Distribution of wood taxa from corn drying kilns by location (n = 4,618)

Table 4.3.11 Indicator Species Analysis of wood taxa in corn drying kilns (values in red are strongest indicators >25) **(*p* = <0.05)**

Taxon	County	Indicator Value (IV)
Fraxinus excelsior	Tipperary	**44.0**
Corylus avellana	Tipperary	**59.3**
Prunus spinosa	Kilkenny	20.9
Maloideae	Tipperary	**37.1**
Salix	Tipperary	**31.6**
Prunus avium	Tipperary	14.9
Quercus	Kilkenny	**51.0**
Prunus types	Kilkenny	**35.7**

Seed = 5233 **p = 0.009** **No. of counts: 4,618**

When the charcoal dataset is arranged chronologically using percentage frequency to evaluate any changes to wood use in kilns over time, there was a notable difference in wood variation between corn drying kilns dating to pre-tenth century and kilns from the post-tenth century period. The most obvious pattern detected was the significant decline in ash and hazel values from earlier to later kilns while the presence of oak increases in kilns dating from the tenth century and later **(Figure 4.3.28).**

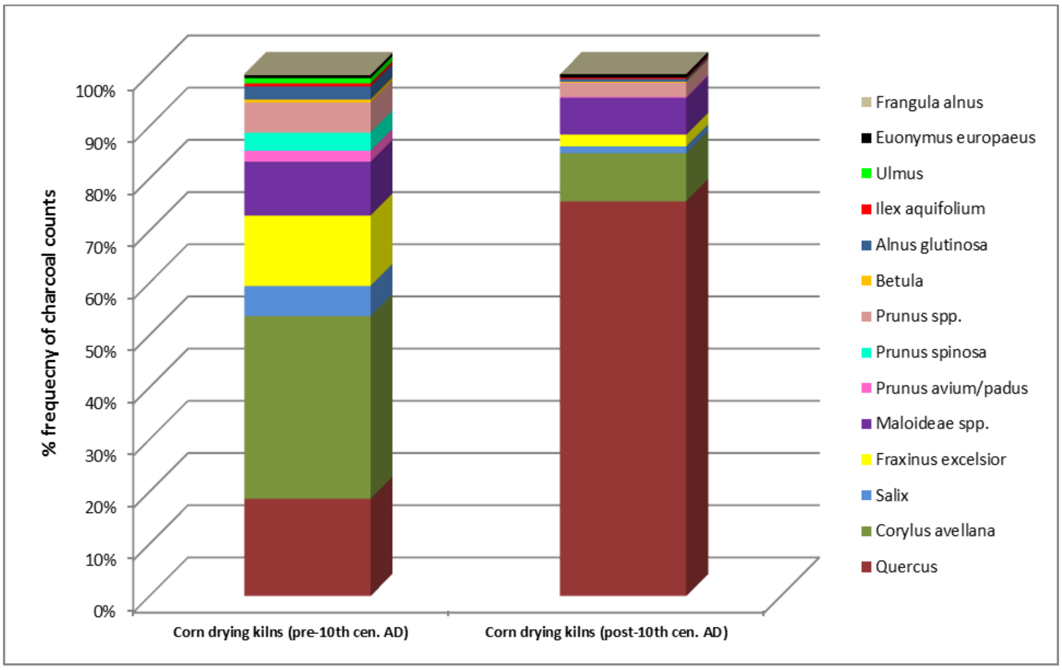


Figure 4.3.28 Distribution of wood taxa from pre-10th century and post-10th century corn drying kilns

Observing the charcoal data for each kiln on each site, it is possible to view the variance in wood composition between early medieval and later medieval kilns and the changes that are occurring **(Figures 4.3.29** and **4.3.30).** The general trend emerging is the preponderance of hazel from the earliest dated kilns, c. fifth century AD, recorded at both locations, such as Holdenstown [Kiln 182] and Templemartin [Kiln 3] in Kilkenny and Monadreela (Site 11) [Kiln 38] and Ballydavid [Kiln 287] in Tipperary. From the c.sixth/seventh century AD, there is an obvious shift to using an admixture of wood taxa, where there is a rise in ash, the Maloideae woods and the *Prunus* wood types, among others. This is evident from kilns at Hughes' Lot East, Monadreela (Site 5), Borris AR33 and Gortmakellis in Tipperary and Kellysgrange and Milltown in Kilkenny, where ash and the fruitwood species (Maloideae and *Prunus*) are notably higher.

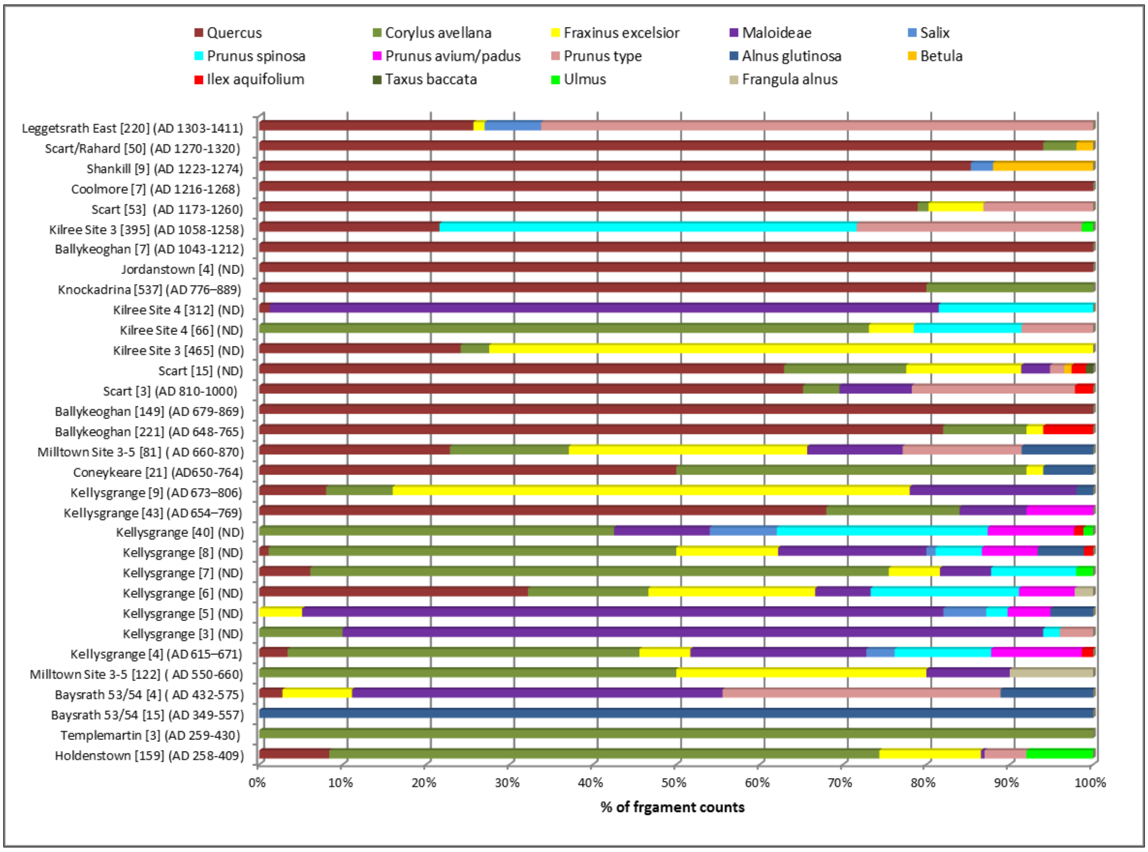


Figure 4.3.29 Distribution of wood taxa from corn drying kilns in Kilkenny (n = 2,336)

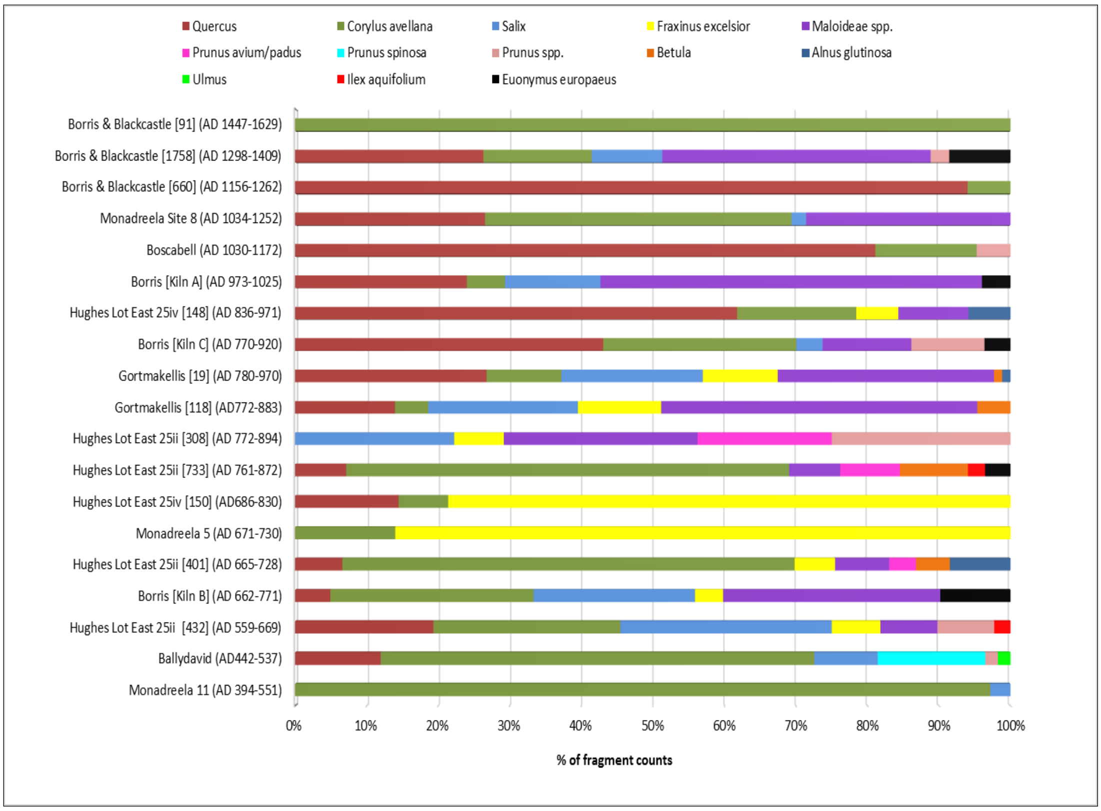


Figure 4.3.30 Distribution of wood taxa from corn drying kilns in Tipperary (n = 2,282)

Conversely, it is also worth noting that kilns dating to this phase where oak is the dominant wood taxa, have somewhat less wood diversity and there is a general absence of ash at the same time. This is a feature of kilns from Ballykeoghan [Kilns 149 and 221], Coneykeare, Kellysgrange [Kiln 43], Knockadrina, and Borris [Kiln C]. By c. tenth century AD oak becomes more prevalent in kilns and there is an obvious decline in ash and hazel overall. While the Maloideae and *Prunus* wood species continue to be in use, there is a decrease in the overall variance of wood taxa compared to pre-tenth century AD kilns. This trend is recorded from kilns in both counties, such as Monadreela (Site 8), Boscabell and Borris/Blackcastle AR31 in Tipperary and Ballykeoghan [Kiln 7], Scart [Kiln 20], Coolmore and Scart/Rahard in Kilkenny.

One of the main patterns emerging thus far from the pit, structural and ditch features is the relationship between oak and ash. As previously demonstrated, the use of ash within particular activities, such as building, declines in favour of oak at certain sites particularly those dating to pre-tenth century AD. From c. tenth century AD, ash values are then seen to decline overall from the majority of sites and it does not feature in the charcoal record as prominently as it did in earlier medieval phases. This could therefore help to explain the high oak values in the presence of low or absent ash charcoal from many of the pre-tenth century AD corn drying kilns e.g Ballykeoghan [Kilns 149 and 221], Coneykeare, Kellysgrange [Kiln 43], Knockadrina, and Borris AR33 [Kiln C].

When the frequency of each taxon is plotted against each other, the line graph **(Figure 4.3.31)** displays the opposing use of oak and ash within these features. Ash values peak in kilns dating from c. seventh to ninth century AD before gradually decreasing from c. tenth century AD, at which point there is a significant rise in oak. The variance in how oak and ash are being used in corn drying kilns therefore closely mirrors the relative use of these taxa in other activities (i.e structures, ditches and pits), as previously deomstrated. The shift to a dominant use of oak in kilns from the c. tenth century AD and later is also reflected more broadly in structures, ditches and pits, which further emphasises that kilns are proving to be good indicators of when oak is being used or not on site.

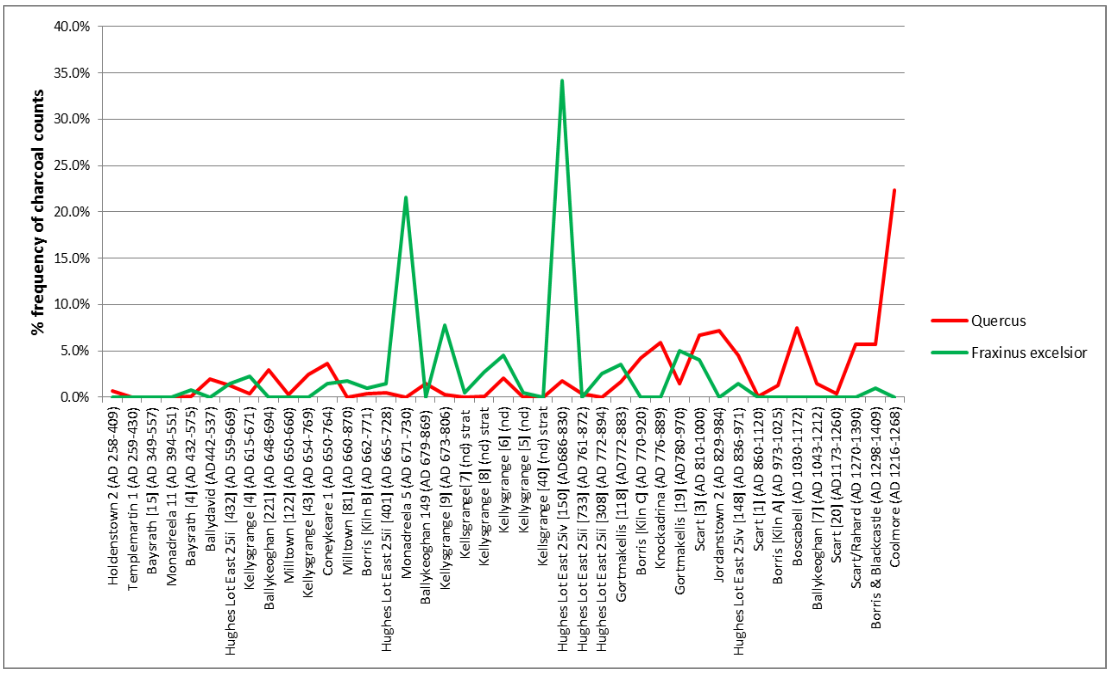


Figure 4.3.31 Comparisons between frequency of *Quercus* (oak) and *Fraxinus* (ash) from medieval corn drying kilns (n = 1,741)

This invariable use of when ash and oak occur in corn drying kilns is therefore testament to how sensitive these features are to changes to on-site wood use during the medieval period, particularly in the earlier fifth to tenth century phase. Furthermore, it also demonstrates that the use of oak fluctuates during this time, potentially influenced by its relative availability or resource management at a site, during which time ash then seems to be used as its substitute.

It is assumed from the large quantity of charcoal remains studied from the corn drying kilns that the taxa identified largely represent the composition of woods used to fuel these features. It was not possible to fully discern structural wood from firewood in most cases, with the exception of some examples from Ballydavid, Gortmakellis and Twomileborris, Co. Tipperary and Scart and Leggetsrath, Co. Kilkenny, where brushwoods of hazel, willow and fruitwood species may represent structural components. Kilns dating to the early medieval period (fifth to the eleventh century AD) largely contained more hazel charcoal from bowl/chamber deposits, while those dating from the later medieval period (post-twelfth century AD) fluctuated between *Prunus* type and willow. Explicit details of the material used in the construction of kilns are not well documented, with generic references to the use of ‘wood’, ‘thatch’ or ‘peat’ often used to describe the fabric of the kiln or the fuel used.

The sample-sets from the aforementioned kilns were too low in number however (<100 charcoal fragments overall) to perform any meaningful statistical analysis and so will not form any discussion within this thesis. There is scope however for more work in this area, which does require further attention, so that a fuller picture of kiln construction, maintenance and fuel procurement can be presented.

Hearths

A total of 849 charcoal fragments from 24 mediveal hearths were analysed as part of this study. *Quercus* sp. was the dominant taxa recorded, accounting for 58% (495 counts) of the overall assemblage, followed by *Fraxinus excelsior*, which made up 13% (109 counts). Maloideae species represented 9% (78 counts), *Corylus avellana* 8% (68 counts), *Salix* sp. 6% (50 counts) and *Alnus glutinosa* 2% (18 counts). The *Prunus* species (*Prunus* sp., *Prunus spinosa* and *Prunus avium)* along with *Betula* sp. made up 1% or less (<15 counts) of the hearth charcoal assemblage **(Figure 4.3.32).**

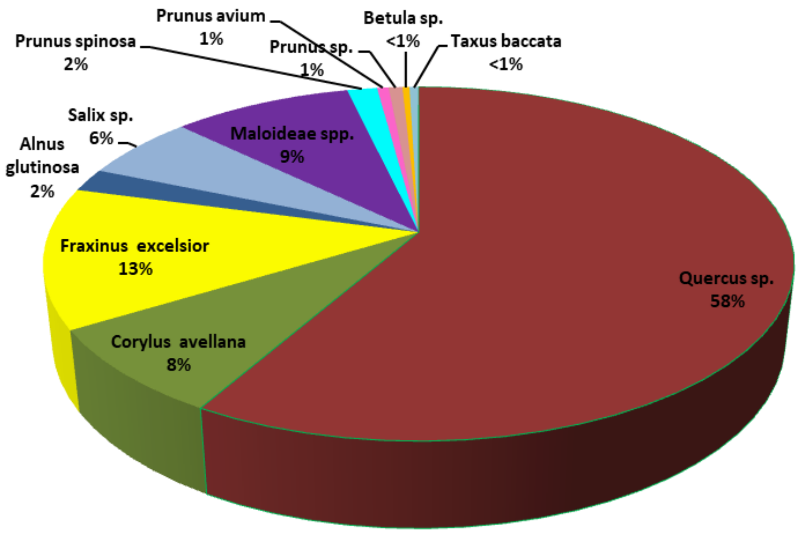


Figure 4.3.32 Percentage of wood taxa from hearths (n = 849)

Similar to pits, structures, ditch and corn drying kiln features, the distribution of wood taxa from hearths displayed comparable results when each site was compared chronologically. A variable mix of wood species was evidence from features dating from the fifth to tenth century AD, with some sites (e.g. Toureen Peckaun, Tinvaun and Moanduff) showing high values for oak within hearth deposits. At sites where oak values were lower, a more admixture of wood taxa was present, such as at Holdenstown, Gortamkellis and Hughes' Lot East. From the tenth century and later, oak values rise, while other species fall, which is particularlay noticeable from Monadreela (Sites 8 and 9), Shankill and Rahard West **(Figure 4.3.33).**

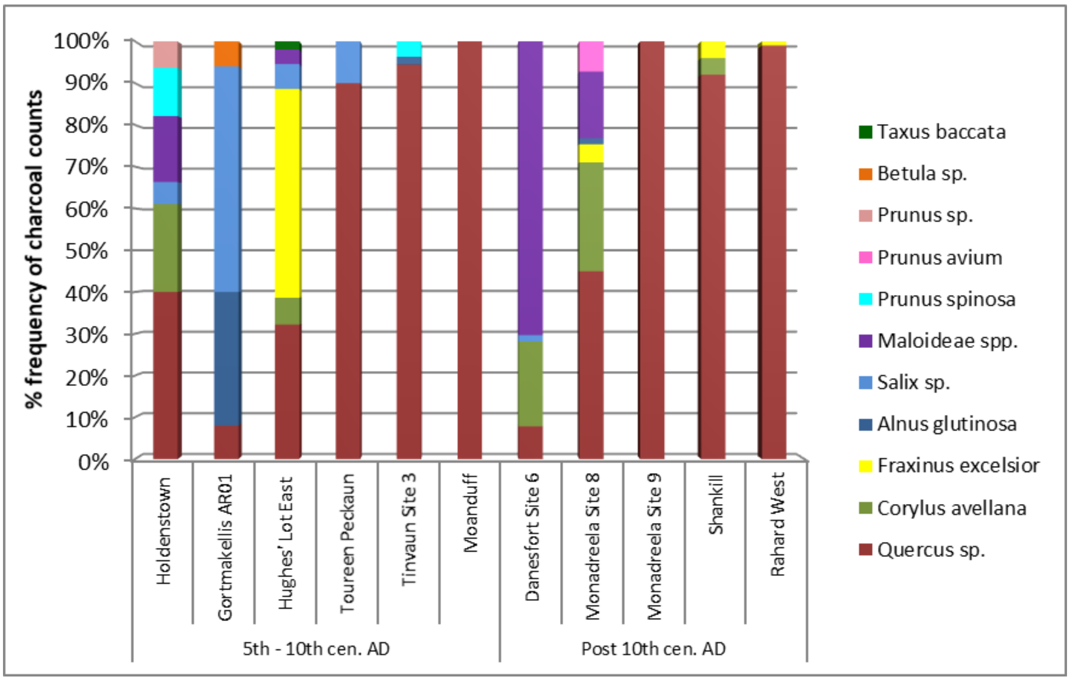


Figure 4.3.33 Distribution of wood taxa from hearth features

To establish if the inter-dependent relationship between oak and ash exists within this set of features, both values were plotted against each other. Once again ash is more prominent from the early medieval phase, while oak remains high and constant from and during the later period **(Figure 4.3.34).**

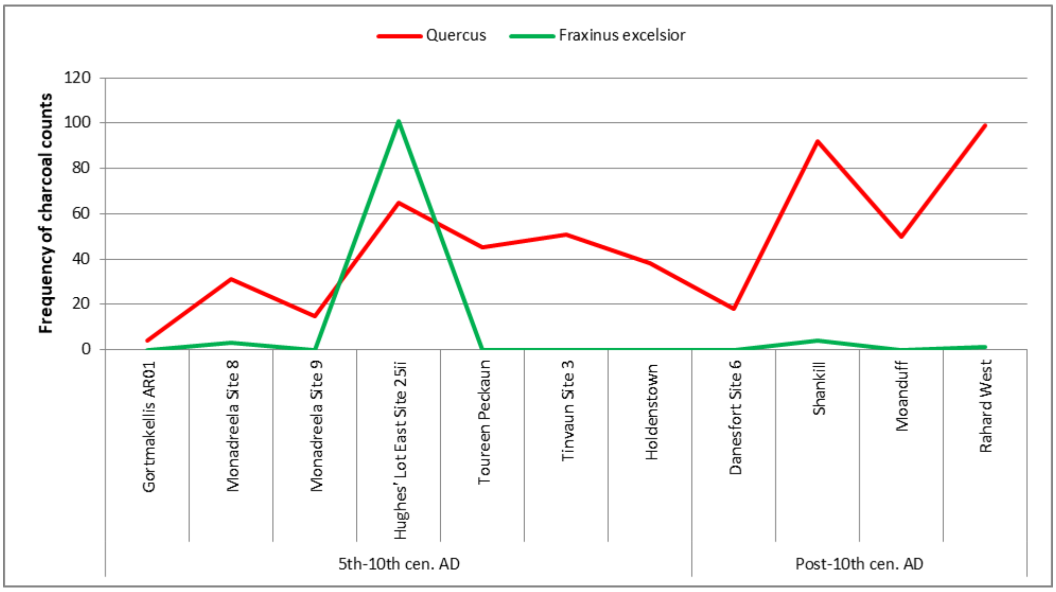


Figure 4.3.34 Comparisons between frequency of *Quercus* (oak) and *Fraxinus* (ash) from hearth features (n = 566)

4.3.5 Distribution of wood taxa by feature

When the distribution of wood taxa from each set of features is compared, some very interesting and pertinent patterns become apparent. While oak, hazel and ash are the mainstays, they vary in abundance. Oak is found to dominate metalworking and charcoal production pits (>80%) and makes up over 50% of the charcoal assemblages from hearths and souterrain deposits. Hazel for example is found frequently (30%) in corn drying kilns and less in ditch deposits, hearth and spreads, while ash is most prevalent (20%) in structural features (i.e. postholes, stakeholes and slot trenches). The distribution of willow and alder is of interest, particularly from well-defined ditch deposits, where both taxa are relatively high (10-20%) when compared to the ash and hazel assemblage from the same features **(Figure 4.3.35).**

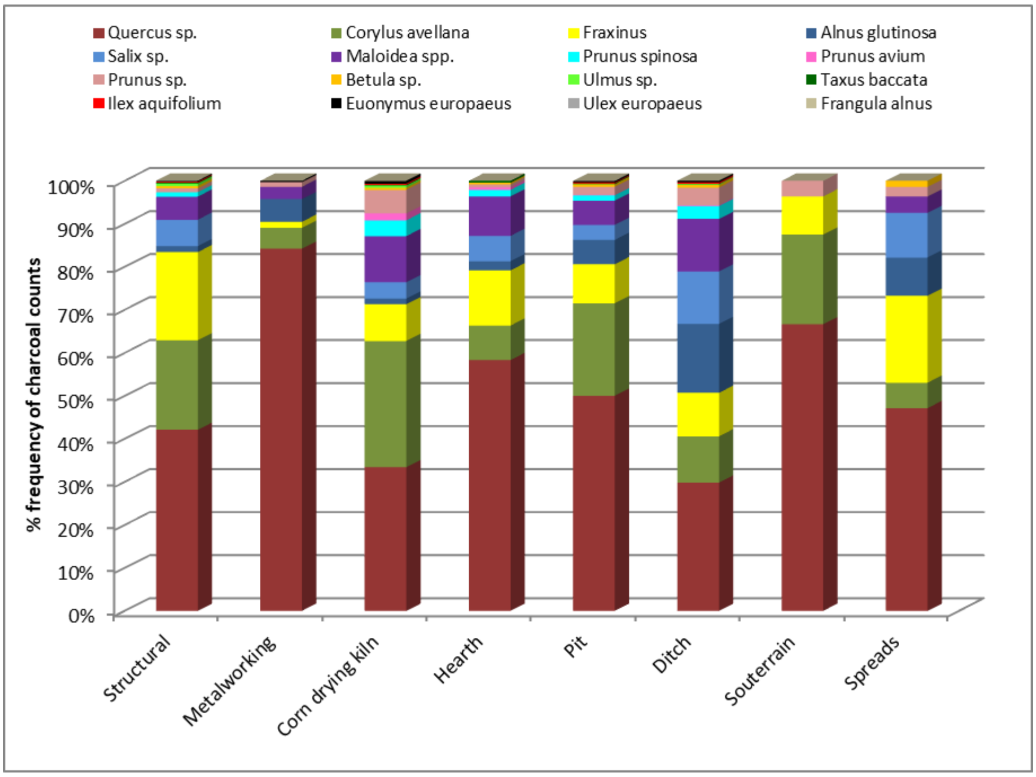


Figure 4.3.35 Distribution of wood taxa from the main features recorded (n = 20,953)

Another significant group of taxa worth exploring more is the fruitwood species (Maloideae and *Prunus* sp.). With the exception of souterrains, the Maloideae wood group were identified from all features in particular the corn drying kilns, hearths and ditch features (10%). The *Prunus* species, such as *Prunus spinosa* (blackthorn) and *Prunus avium/padus* (wild/bird cherry) were also a feature of corn drying kilns predominantly, with notable occurrences from ditch deposits also (5-10%).

To support this observation of wood taxa abundance and frequency per feature, ISA revealed that ash and oak were indicative of structural features; hazel, the *Prunus* and Maloideae wood groups are predominantly associated with corn drying kilns, while willow and alder are both taxa more concomitant to ditch features **(Table 4.3.12).**

Table 4.3.12 Indicator Species Analysis of wood taxa by feature type (values in red are strongest indicators >25) (*p<0.05*)

Taxon	Feature	Indicator Value (IV)
Fraxinus excelsior	Structural	**38.6**
Quercus sp.	Structural	**25.6**
Corylus avellana	Corn drying kiln	**44.1**
Maloideae spp.	Corn drying kiln	21.9
Prunus spinosa	Corn drying kiln	14.8
Prunus avium/padus	Corn drying kiln	9.1
Prunus sp.	Corn drying kiln	**26.9**
Ulmus sp.	Corn drying kiln	8.7
Salix sp.	Ditch	**28.0**
Betula sp.	Ditch	12.6
Ilex aquifolium	Ditch	11.0
Alnus glutinosa	Ditch	**36.8**

Seed = 3496 **p = 0.07**

Ordination (NMS) revealed that oak was clustered towards structural features (postholes, stakeholes and slot trenches), indicating the distinct use of oak in medieval construction works **(Figure 4.3.36).** This exercise also emphasised the similarity of wood taxa frequency and diversity between ditch features and corn drying kilns. Oak found in these features (ditches and corn drying kilns) is therefore most likely the product of other primary activity, such as construction works, suggesting that oak kiln fuel was dictated by its availability and usage on a site.

The strongest Pearson's *r*-value scores in NMS **(Table 4.3.13)** further demonstrates that oak use or its presence in features is distinctively different from other taxa. The oak value on Axis 1 is positive (0.266), where all other wood species have a negative value, indicating that when oak is in use, the presence of other taxa is minimised, a trend that was previously observed from the results discussed by phase **(see 4.3.3).** At feature level, oak has an inverted linear relationship with many other taxa, where it increases in line with other woods decreasing at the same time.

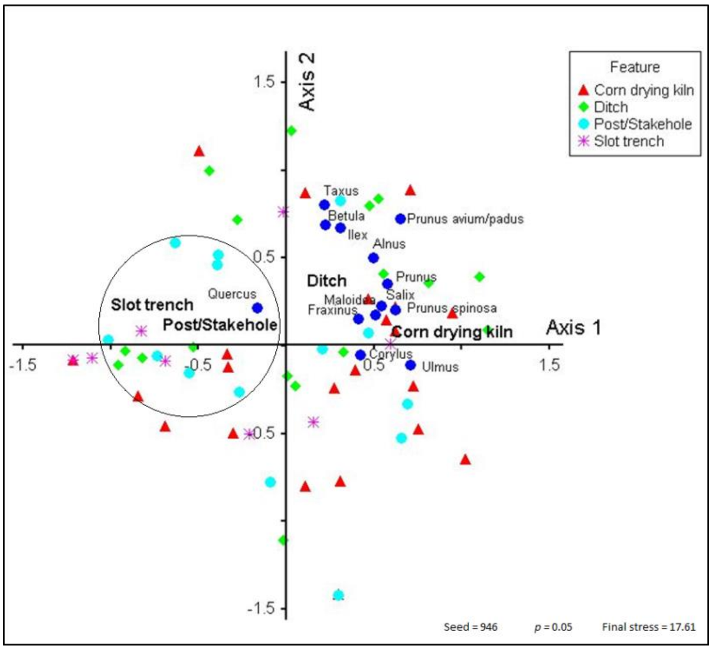


Figure 4.3.36 NMS ordination (Axis 1v 2) of wood taxa from main medieval features

Table 4.3.13 Correlations (Pearson's *r*-value) of explanatory variables in NMS of wood taxa (Values in red are significant at the p<0.05 level for two tailed t-test)

Taxon	Axis 1 *r-value*	Axis 2 *r-value*
Fraxinus excelsior	-0.255	0.093
Salix sp.	-0.377	0.155
Quercus sp.	**0.266**	0.373
Maloideae spp.	-0.373	0.155
Alnus glutinosa	-0.220	0.236
Corylus avellana	-0.428	-0.064
Prunus spinosa	-0.357	0.152
Prunus avium/padus	-0.144	0.164
Prunus sp.	-0.453	0.323
Betula sp.	-0.148	0.457
Ulmus sp.	-0.280	-0.046
Taxus baccata	-0.053	0.233
Ilex aquifolium	-0.201	0.507

To determine what features were more likely to contain a higher abundance of wood diversity and in turn what feature types are more similar to each other with regard to the wood taxa found, the diversity and similarity index was applied to the dataset. **Table 4.3.14** below presents the Simpson Diversity index results, which shows that the highest diversity of wood taxa is found in ditch features (0.84) followed by corn drying kilns (0.78) and surprisingly structural deposits (0.73), while the lowest diversity of species is to be found in metalworking/charcoal production pits (0.29). The value obtained for the latter would of course be as a result of the high oak occurrence from these features, showing high selectively of a preferred species, hence a deliberate and controlled use of wood.

Table 4.3.14 Diversity of wood taxa between features using Simpson Diversity Index

Feature type	No. of samples	No. of counts	Simpson Diversity index
Slot trench	13	852	0.62
Posthole/Stakehole	133	3894	**0.73**
Corn drying kiln	130	4618	**0.78**
Metalworking	22	639	**0.29**
Hearth	11	849	0.63
Pit	120	4693	0.69
Souterrain	11	195	0.51
Ditch	111	3514	**0.84**
Spreads	25	711	0.72

In contrast, the range of wood taxa from ditches, kilns and structures suggests a low selectivity regime associated with or around these activities. This level of diversity is noteworthy within the context of structural features, where PFA and ISA values show oak, ash and hazel to be main composites of these charcoal assemblages. Through the use of sample sufficiency analysis **(Section 3.6.1.4)**, it has already been established that structural features predominantly contain between 1 and 3 wood taxa, however, with the presence of mixed species, which comprised <1% of the charcoal assemblages from these features, the diversity index emphasises their presence. This then considers the range of domestic, craft and industrial activities that were being carried out in and around these structures. The use in range of wood in most if not all of these cases would inevitably provide a readily available on-site supply of tinder and timber for firewood and fuel.

When the features were compared to establish patterns of similarity through the charcoal record using Sørensen’s Co-efficient Index (closer to 1 for similarly), the variance and abundance of wood taxa found in structural deposits is in exact proportion to patterns of wood use in corn drying kilns, pits and ditch features **(Table 4.3.15).** Hearths are also strongly correlated to these features.

Metalworking/charcoal production pits are unsurprisingly less similar to almost all other features, with the exception of spreads and souterrain deposits. This again accounts for the high oak content identified from these features and further emphasises that metalworking/charcoal production pits were distinct from other activities by their fuel supply during the medieval period.

Table 4.3.15 Table of taxa similarity by feature using Sørensen’s Co-efficient Index (significant values in red)

Feature type	Kiln	Pit	Hearth	Metalworking	Ditch	Souterrain	Spread
Structure	**1.00**	**0.97**	**0.88**	0.57	**1.00**	0.33	0.73
Kiln		**0.97**	**0.88**	0.57	**1.00**	0.33	0.73
Pit			0.85	0.64	**0.97**	0.42	0.70
Hearth				0.67	**0.88**	0.53	0.88
Metalworking/Charcoal production					0.67	0.80	0.80
Ditch						0.44	0.72
Souterrain							0.66

If the array of domestic, craft and industrial activities centres on structures (primary use), be it dwelling places or ancillary buildings associated with metalworking or textiles, the resultant offcuts and wood working debris would have been a source of fuel for domestic hearths and corn drying kilns (secondary use). In turn, the periodic cleaning and maintenance of these activities would have been required and designated areas of an open ditch would have facilitated this (secondary/tertiary use).

To further test the strength of the relationship between structures and corn drying kilns as an example of primary and secondary wood use, each set of values are compared through correlation. **Figure 4.3.37** below serves to demonstrate that the frequency and varying abundance of wood taxa from medieval structural features (postholes, stakeholes and slot trenches) and corn drying kilns are strongly correlated at *r = 0.9*.

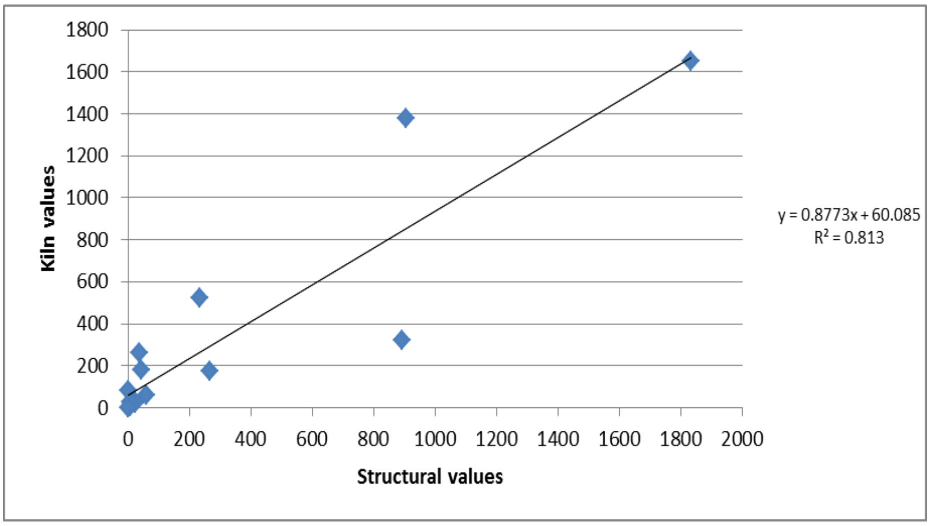


Figure 4.3.37 Correlation between corn drying kilns and structural features (PPMCC) (r = 0.9)

This demonstrates that corn drying kilns were more closely connected to the rhythm and continuity of change that existed through the activities being carried out in or near the dwellings and structures that were focal points on these medieval settlement complexes. This supports and explains the results of the diversity index, where corn drying kilns were subject to low wood selectivity, the consequence of other on-site activities for example construction works, craft, manufacturing and metalworking. This therefore implies that the wood used to fuel corn drying kilns was not an important component in their functionality. The availability of a local wood source dictated the kiln fuel supply, which was accommodated by other on-site activities.

These results also offer new insights into how these features were essentially regarded, considering their pivotal role in the medieval arable practices. If kilns are therefore a measure of how wood resources were used on a site, then it may be possible to use them as a proxy for charting the varying ebbs and flows of medieval wood collection and use, particularly for the early medieval period (fifth to tenth century AD). To test this hypothesis, corn drying kilns will be used as a case study for context-related wood use to ascertain how these features reflect the changing patterns of medieval wood resource use at site level **(see Chapter 5).**

4.3.6 Conclusions

The main results from the wood taxa recorded through features dating to the medieval period is a) the shift from using a diverse mix of wood species characterised by a rise in ash and fruitwood species and interspersed with a high usage of oak from the fifth to tenth century AD to b) an oak dominant, low species diversity scenario on later medieval sites. A striking observation is the decline in ash in the charcoal record from the tenth century and into the later medieval period, supporting the pattern being observed throughout the dataset analysis **(Section 4.3.1).**

Ash is more pronounced in post/stakeholes from pre-tenth century AD sites along with a more variance in wood taxa, where willow, Maloideae, *Prunus,* blackthorn**,** elm, holly and birch are also present. Ditch, pit and hearth features also show that when ash is present, the abundance and variance of other wood taxa also rises. It is also worth noting that sites dating to this phase where oak is the dominant wood taxa, have somewhat less wood diversity and there is a general absence of ash at the same time (e.g. Holdenstown, Danesfort Site 6, Kilree Site 3, Coneykeare, Tinvaun and Borris AR33). This is a trend that is replicated through the corn drying kiln dataset, where a dominant oak in fifth to tenth century AD dated kilns coincides with a lower frequency or absence of ash and other mixed wood species **(Section 4.3.4).** Consequently, when and where ash values are high or notable, so too are the values for other wood taxa.

Considering that the variance and abundance of wood taxa between structural features, pits, hearth, ditches and corn drying kilns are closely correlated during this earlier medieval phase, as demonstrated, the use or availability of oak seems to fluctuate considerably from site to site and indeed within sites at certain times. This is strengthening one of the main assertions being borne out through this thesis that oak use between the fifth and tenth century AD is very variable, shifting from high to low usage, possibly being supplemented with or substituted by a mix of other wood species on some sites (e.g Hughes' Lot East, Toureen, Kilree, Kellysgrange and Farranamanagh).

Correlation values support this, where the use of oak is clearly distinguished from other taxa, with the exception of hazel in structural deposits. This raises questions about the factors then that influence oak use during this earlier period – how frequently available was it; who had access to it; how was it being managed and distributed and does absence of evidence mean evidence of absence? The charcoal data from structural and ditch features therefore mirrors the broader trends being highlighted through the medieval charcoal record and further emphasises that despite variability across all features, a change in wood resource use is occurring from around the tenth century AD.

This could signify a change in the status or functionality of a settlement, where oak found more abundantly and evenly across features is a response to its relative use or frequency on that site or how that site was ranked in a social or economic setting. If this model is applied to mixed wood assemblages where oak and ash fluctuate, then perhaps not all sites are equal in a social, economic or functional context. Whether the use of a mixed wood assemblage represents lower graded settlement, facilitates seasonal activities or those of lesser economic importance or highlights a site's proximity to oak woodland, there is the question of resource control and distribution.

Determining levels of oak use through its presence and occurrence across a site considering all archaeological activity therein could therefore be a fundamental indicator of how settlements operated and the prestige held through regulating the oak wood supply. The dataset from the corn drying kilns will expand on this more, where wood used to construct, fuel and maintain a specific domestic activity, within a confined and controlled environment, under strict regulation will provide a profile of context-related wood use contemporary to other site activity. Chapter 5 will investigate these findings in more detail at site and context level to establish if the broad trends observed are represented more locally.

5 Case Studies

5.1 Introduction

This chapter presents a series of case studies, used to demonstrate if the shifts and variance in wood use patterns being observed through the charcoal record during the medieval period were present at local level. This exercise also investigates context-related variation at each site, to understand local wood selection and the management strategies being employed for specific activities. Three contemporary sites located within a 20km radius in Tipperary showing a continuity of settlement activity dating from the sixth to the fifteenth century were selected – the enclosed settlement at Hughes' Lot East (fifth to eleventh century AD); the enclosed settlement complex and mill at Borris and Borris/Blackcastle (sixth to fifteenth century AD) and the medieval ecclesiastical settlement at Toureen Peckaun (seventh to eleventh century AD). In addition, to understand specific context-related wood use from single/short phased activity, corn drying kilns were used to demonstate and chart the fluctuating patterns of wood resource use at local level.

5.2 Twomileborris, County Tipperary (E2374/E2376) (Stevens 2010a, Stevens 2010b)

Due to their close proximity, the medieval settlements at Borris (AR33) and Borris/Blackcastle (AR31) will be merged and discussed together under their townland name of Twomileborris.

5.2.1 Historical background

The site at Twomileborris is located just 8km from Thurles and c.20km northeast of Cashel town and Hughes' Lot East **(Section 5.2)**. Borris townland falls within the modern parish of Twomileborris and the barony of Eliogarthy, Co. Tipperary North Riding. It is bounded by the townland of Twomileborris to the north, Blackcastle to the northwest, Lahardan to the west, Monaraheen to the southwest, Ballyerk to the south, Noard to the southeast and Leigh to the east. The majority of the townland is undulating pasture drained by the Black river **(Figure 5.2.1).**

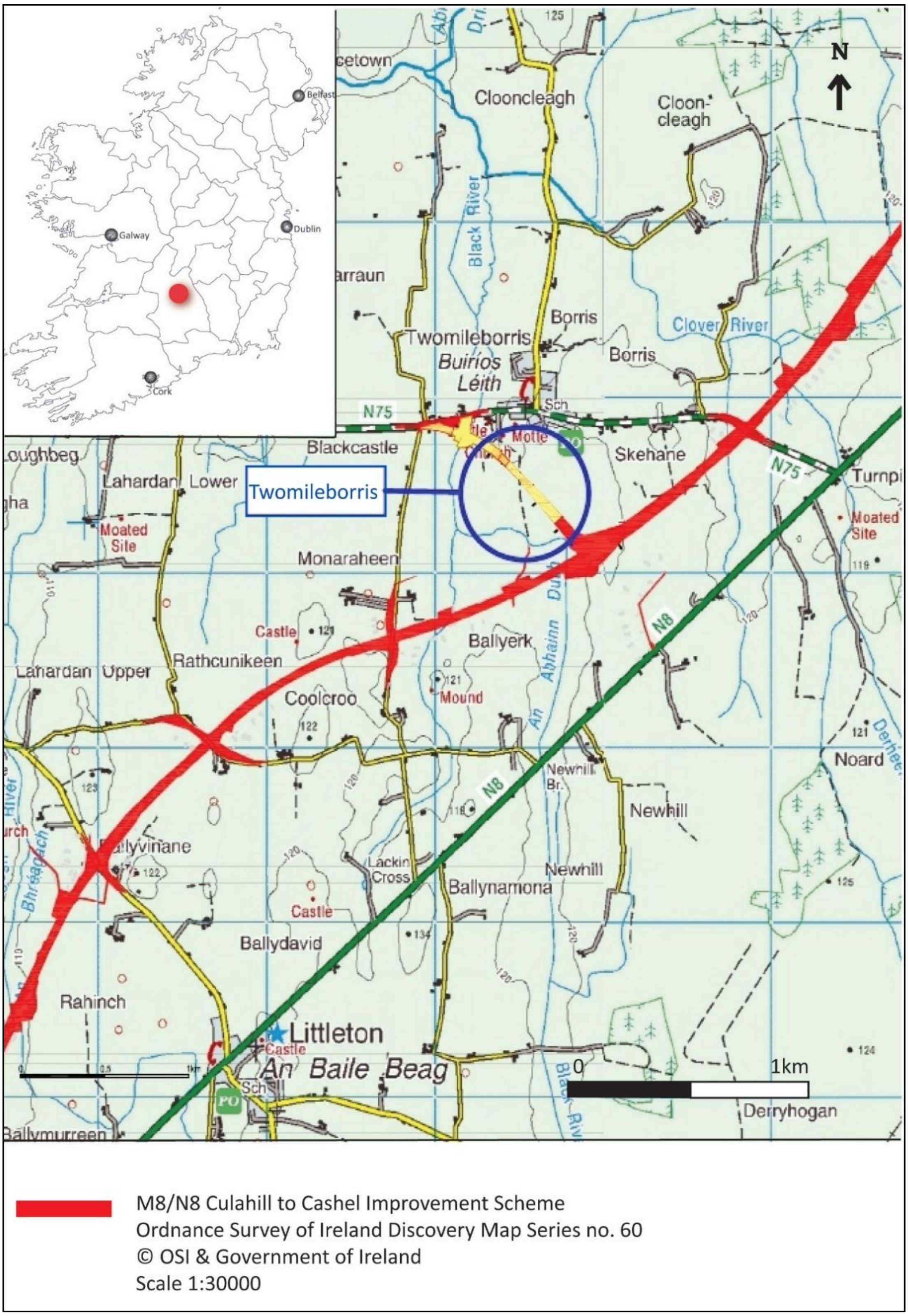


Figure 5.2.1 Location of Twomileborris, Co. Tipperary

The sites and monument records (RMP) have 10 medieval dated sites listed for Borris **(Table 5.2.1; Figure 5.2.2):**

RMP reference	Site classification
TN042-038	Enclosure of unknown date
TN042- 037	Ringfort
TN042: 052	Medieval deserted village
TN042: 052001	Castle/towerhouse (Black Castle)
TN042-052002	Church
TN042: 052003	Castle/ringwork
TN042: 052004	Grave slab
TN042:052005	Watermill
TN042-052006	Graveyard
TN042: 053	Moated site

Table 5.2.1 List of RMP monuments close to Twomileborris

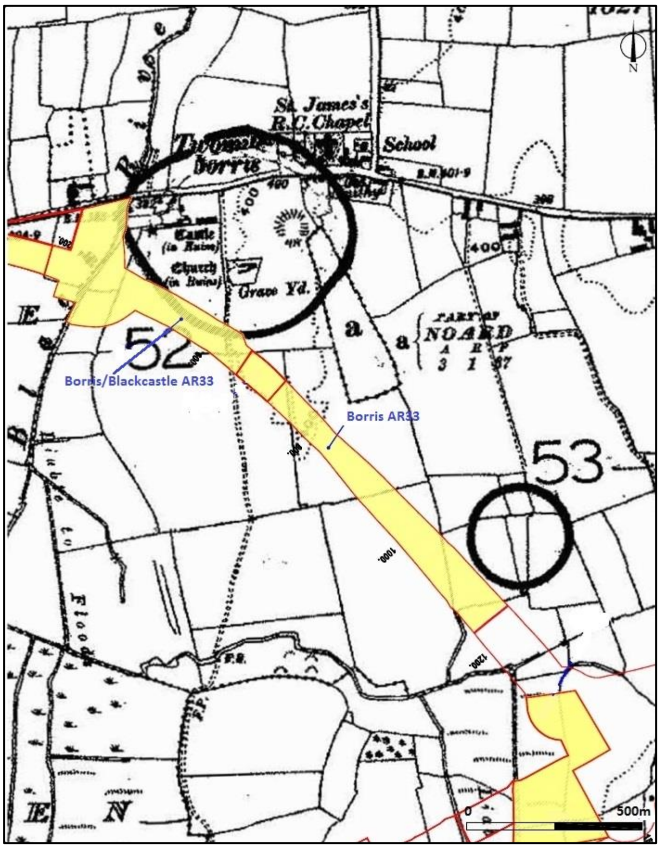


Figure 5.2.2 Recorded sites (RMP) located near Twomileborris

The 1st edition (1839-40) and 2nd edition (1905) Ordnance Survey maps indicated the presence of extensive field systems. The land in the immediate environs of the site was primarily used for agriculture. The townland name of Borris likely comes from the medieval "Burgage" and may refer to the medieval Anglo-Norman settlement *Buirios Ui Liath*/Burgage leeth.

Archaeological excavations carried out as part of the N75 link road and the N8/M8 Cullahill to Cashel road scheme uncovered a previously unknown medieval settlement complex spanning from c.450 AD to 1550 AD. The area comprising two separate sites (Sites AR31 and AR33) which extended c.950m along the N75 link road, midway along the N8/M8 road scheme. The central and highest part of the complex was a low glacial ridge 119m OD. The site extended north and south of this ridge, sloping gently towards low-lying areas adjacent to the Black River to the west.

5.2.2 Archaeological background

Early medieval settlement complex:

(Borris: AR33) (Stevens 2010b)

NGR: E219123/N157755 ITM: E619331.2801/N657685.3484

The early medieval activity at the site (AR33) was characterised by three enclosures (A-C), which were consecutively phased, displaying a continuity of settlement occupation from the 5th to the 11th century AD **(Figure 5.2.3).** The first phase of activity consisted of an oval 'plectrum-shaped' enclosure (Enclosure B) defined by a shallow ditch, with an elaborate entrance and interior palisade. The enclosure measured 42m in diameter, with an entrance of 3.2m wide on the ESE side. The defensive nature of the enclosure suggested by the stout entrance posts reinforced by the presence of a partial internal palisade was defined by a series of postholes identified in the north and east of the enclosure only. The base of the ditch was radiocarbon dated to AD 400-560 (Poz-25204). The interior of Enclosure B contained a circular structure (Structure V) (5.5m diameter), with a series of, hearths, roasting pits and dispersed domestic pits excavated in the vicinity.

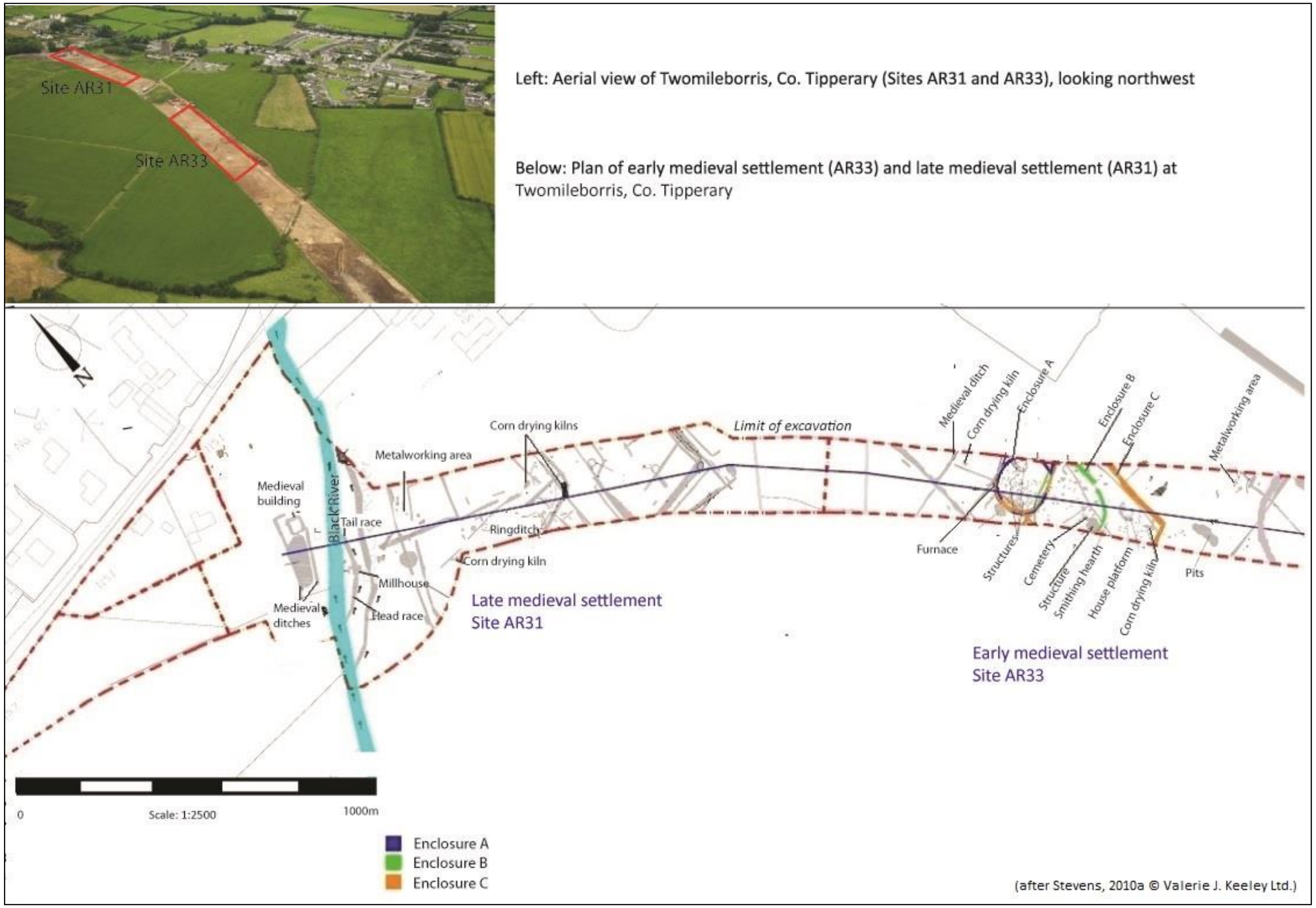


Figure 5.2.3 Ground plan showing the early medieval settlement (AR33) and later medieval settlement (AR31) at Twomileborris, Co. Tipperary

The second phase of enclosure activity saw the construction of a small ringfort (Enclosure A). Enclosure B had fallen into disuse and the ditch filled up before the construction of Enclosure A, suggesting no continuity from the Phase 1 settlement and the Phase 2 settlement. Enclosure A was constructed over the northern part of Enclosure B, with an east-facing entrance (3.2m wide) flanked by at least one large posthole. The interior contained the remains of at three circular structures (Structure I, III and IV) (c.5m diameter), defined by internal postholes and in two examples, by shallow curvilinear gullies. The basal fill of the ringfort produced a date of 677-774 Cal AD (UBA-9100), a posthole from Structure I [787] was dated to 648-765 Cal AD (UBA-12495) and a central hearth [131] dated to 680-774 Cal AD (UBA-12501) **(Figure 5.2.4).**

Several iron knives, a quern stone fragment, a glass bead, a stone gaming board and 26kg of animal bone were retrieved from the ditch. To the north of the enclosure was a series of linear ditches where the remains of a corn drying kiln [1145] (Kiln C) and working pits were located. Kiln C was radiocarbon dated to 662-771 Cal AD (UBA-12502) and a charcoal-rich pit dated to 673-856 Cal AD (UBA-12504). A metal working complex containing both ferrous and non-ferrous metalworking was identified to the south of the enclosure, which dated to 673-856 Cal AD (UBA-12503) and 717-887 Cal AD (UBA-12500) **(Figure 5.2.5).**

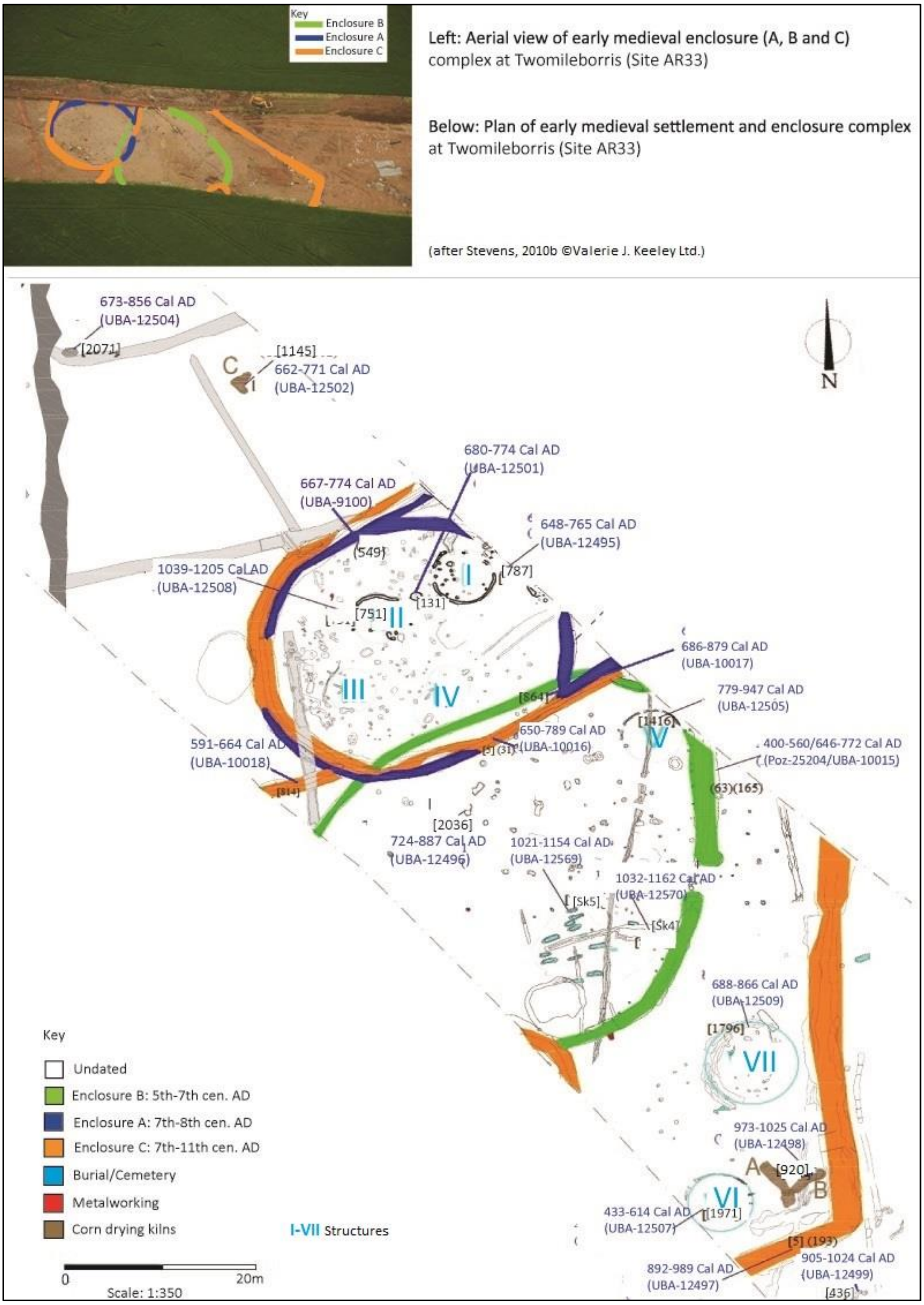


Figure 5.2.4 Plan and aerial image of early medieval settlement and enclosures A, B and C at Twomileborris, Site AR33

The later phase of enclosure activity was a continued use of the ringfort (Enclosure A), where the northern part of Enclosure A was widened and deepened and settlement moved southward with the construction of a larger rectangular enclosure at the southern extent of the site. This modification (Enclosure C) measured approx. 55m east-west and 87m north to south and a date from a basal deposit (193) yielded a radiocarbon date of 892-989 Cal AD (UBA-12487). The extension allowed for a wider range of activities to take place inside the perimeter of the new settlement design. Two iron knives, metallurgical residues and 76kg of animal bone were recovered from the ditch.

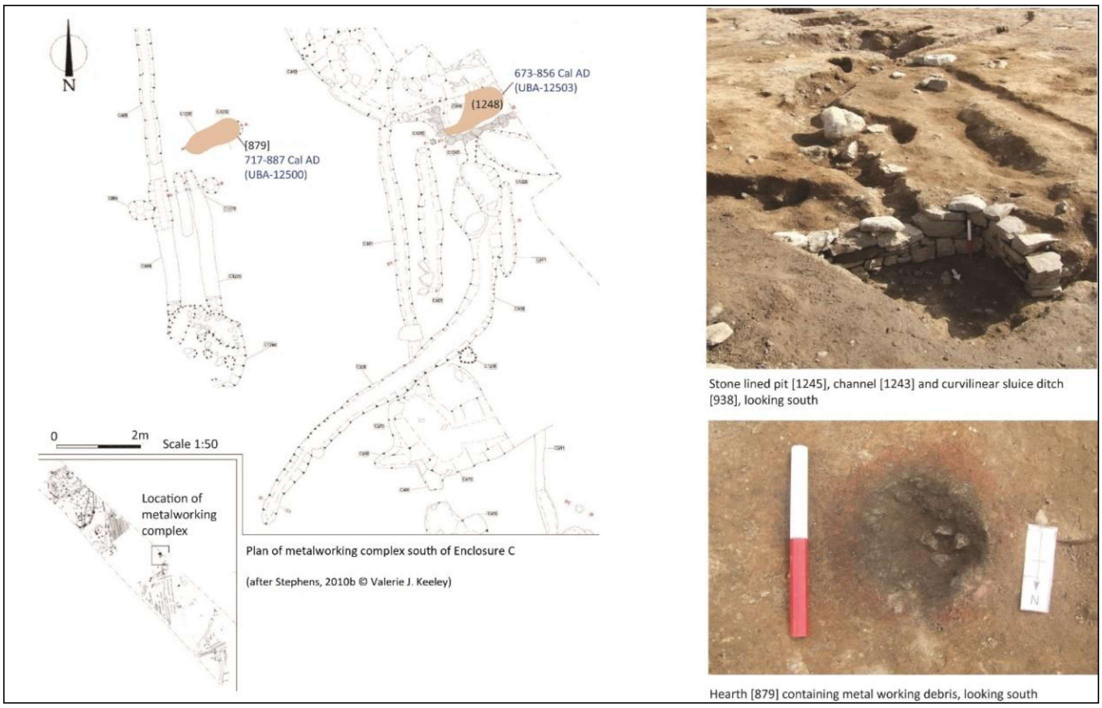


Figure 5.2.5 Early medieval metalworking complex located south of enclosure complex on Site AR33

Just inside the enclosure to the south were two corn drying kilns [525 and 920] (A and B), the latter of which was dated to 973-1025 Cal AD (UBA-12498) **(Plate 5.2.1).** A four post structure and circular structure (Structure II) were also present in the interior, a posthole [751] from the latter of which was dated to 1039-1205 Cal AD (UBA-12508). A series of charcoal pits were situated to the south of the enclosure, one of which [436] dated to 905-1024 Cal AD (UBA-12499). The remains of an unenclosed cemetery was identified in the interior of Enclosure B. Twenty burials in addition to a small quantity of disarticulated skeletal material were identified. The burials were located in the southern quadrant of Enclosure B and radiocarbon dating from two of the burials (Sk 4 and Sk 5) dated the remains to 1021-1154 Cal AD (UBA-12569) and 1032-1162 Cal AD (UBA-12570).

Corn drying kiln [525], looking northwest

Kiln/pit [2071], dated 673-856 Cal AD (UBA-12504), looking north-nothwest

Corn drying kiln [920], dated 973-1025 Cal AD (UBA-12498), looking southeast

(Stephens, 2010b © Valerie J. Keeley Ltd.)

Plate 5.2.1 Early medieval corn drying kilns on Site AR33

Late medieval settlement complex: (Borris/Blackcastle AR31) (Stevens 2010a)
NGR: E219538 N157497   ITM: E619484.2466 N657540.3794

Site AR31 was located just 400m to the northwest of the early medieval enclosure complex. This site comprised the remains of a later medieval settlement dating from the thirteenth/fourteenth century AD, which included a rectangular building, two vertical watermills to the north and south, three corn drying kilns, a metalworking complex and several enclosures. The earliest mill structure comprised the remains of a headrace, the timber sluice (T19) of which had survived *in situ* and was dendrochronologically dated to AD 1118±9 (Q11042) **(Figure 5.2.6).**

Figure 5.2.6 Top: Location plan and elevated view of vertical watermill of Site AR31, showing main components of the mill, looking south/southwest

Located less than 20m to the north, the remains of a second vertical mill was identified. It comprised the foundations of a mortared stone mill house building [737], adjacent wheel pit, parallel horizontal mill timbers (components of the mills water management system), headrace, tailrace, and overflow channel and a stone construction thought to represent a deflection dam. Two of the surviving mill timbers (T5 and T8) were dendrochronologically dated to 1208 + 9 years (Q11037) and 1188 + 9 years (Q11041) respectively.

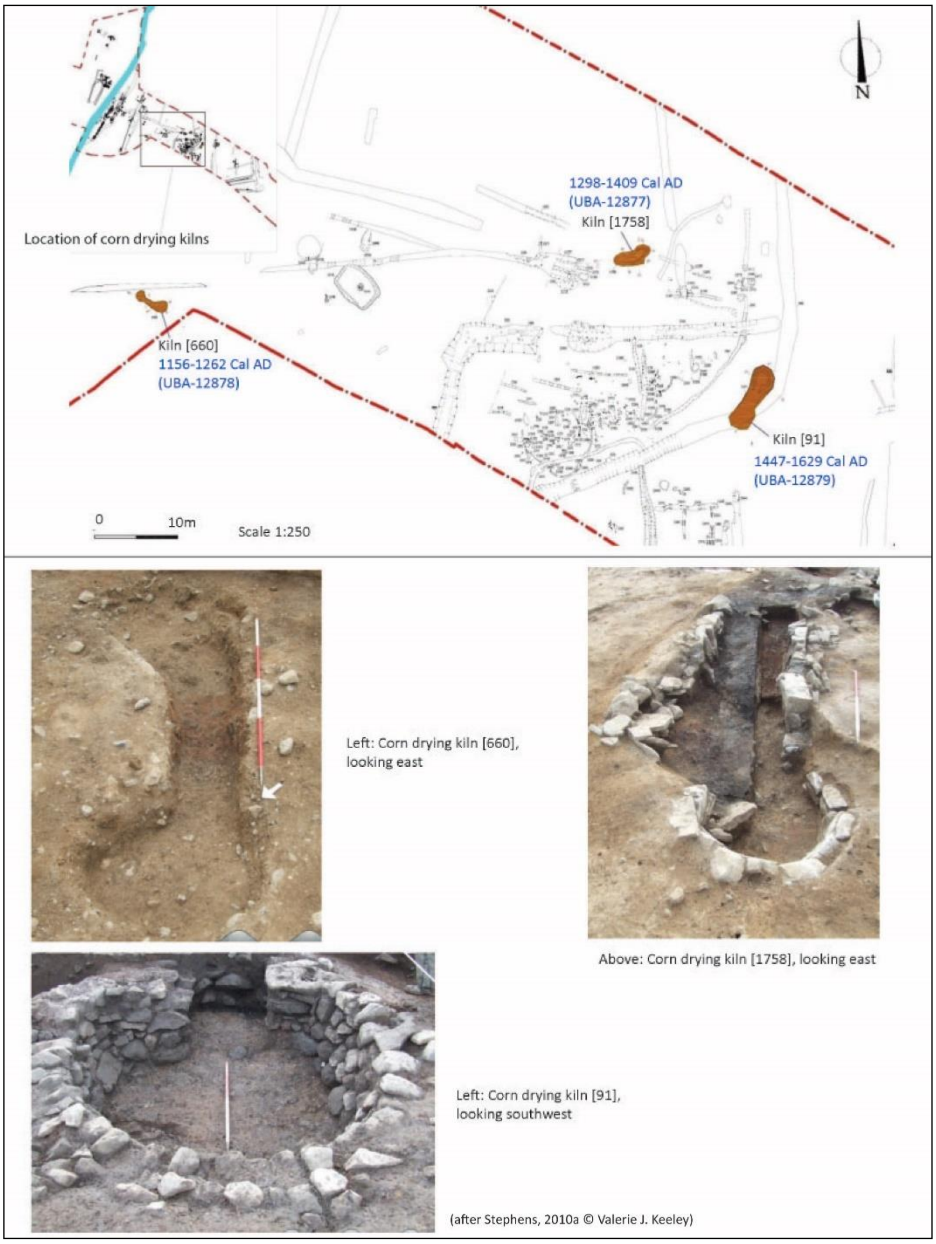


Figure 5.2.7 Top: Location plan of late medieval corn drying kilns on Site AR31; Bottom: Corn drying kilns [91], [660] and [1758] on Site AR31

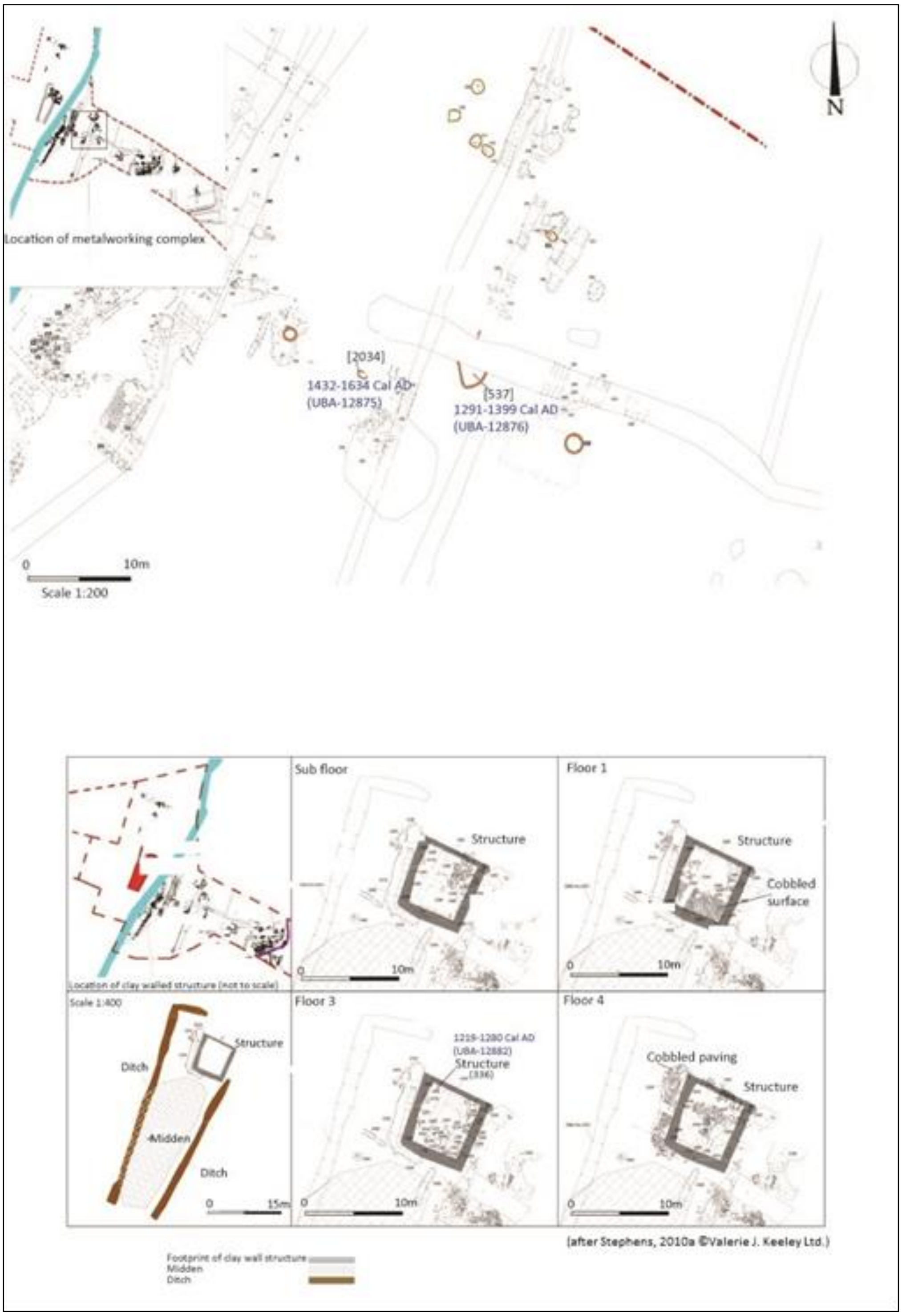


Figure 5.2.8 Plan of late medieval metalworking complex and rectangular clay-walled structure on Site AR31

Three medieval cereal-drying kilns were also excavated [91, 699 and 1758], on a gently sloping, north-west-facing terrace c.75 m east of and overlooking the mill **(Figure 5.2.7).** The ‘dumbbell/keyhole’ type kilns were all cut into the subsoil, with kiln [91] being stone-lined. Each kiln was radiocarbon dated and produced a range of dates - 1156-1262 Cal AD (UBA-12878) [660]; 1298-1408 Cal AD (UBA-12877) [1758] and 1447-1629 Cal AD (UBA-12879) [91]**.** All three contained deposits rich in carbonised cereal grains (barley, oat and wheat), denoting that the kilns had burnt down and were probably abandoned.

A small domestic structure was excavated adjacent to the west bank of the Black River, in the adjacent townland. It measured 5.8 m by 6 m, was of earthen/clay wall construction and contained the remains of four well- preserved floor surfaces **(Figure 5.2.8)**. A deposit (3356) of the clay-walled structure was radiocarbon dated to 1219-1280 Cal AD (UBA-12882). This upper floor layer (536) was dated to 1291-1399 Cal AD (UBA-12876). The final period of use is thought to have been related to metalworking, perhaps smithing activity. A midden type deposit to the south of the structure produced several sherds of both domestic pottery (Leinster coking ware; Cashel-type ware, Waterford 'A' ware) and imported pottery, which included the 13th century Redcliffe Ware and Cologne stoneware (mid-16th century).

The metalworking activity on this site continued from the earlier medieval phase identified on Site AR33. Two furnaces and three smithing hearths, was excavated to the east of the mill. The presence of primary and secondary iron smithing on site was noted in particular, smelting. The radiocarbon dates for this activity, highlighted two phases of metal working at the site – hearth [537] dated to 1291-1399 Cal AD (UBA-12876) and smithing pit [2043] dated to 1452-1634 Cal AD (UBA-12875). Industrial activities of the type identified at Twomileborris may well have taken place on the outskirts of many medieval boroughs. The trading of agricultural surpluses, the products of metalworking and other crafts were important parts of the local and regional economy. Evidence for luxury imported goods was present in the form of imported pottery from Britain and France. Pottery vessels containing wine and oil, landed at the great medieval trading port of Waterford, perhaps found their way upstream along the Suir and its tributaries to Twomileborris. The monetary nature of this economic activity is shown by the recovery of a hoard of 53 silver pennies (Edward I and Edward II 1280-1320). The evidence shows that the borough at Twomileborris was very much a part of the wider Anglo–Norman world.

5.2.3 Bayesian modelling for Twomileborris

To construct a Bayesian in-depth model for the activity at AR31 (Borris) and AR33 (Borris/Blackcastle), each site was modelled separately. A total of 31 radiocarbon dates and three dendrochronological dates from oak timbers associated with the vertical mill were obtained from the sites in total **(Table 5.2.2).** All radiocarbon dates were calibrated in OxCal 4.1, using IntCal 2009 (Reimer et al. 2009).

Early medieval settlement complex (AR33)

A total of 22 radiocarbon dates from AR33 were used to construct a Bayesian model to help refine the chronology for this early medieval settlement complex. While the majority of the dates for the second phase ringfort activity (Enclosure A) remained largely unchanged, the model provided new determinations for the earliest phase of the site and provided quantitative estimates for the likelihood for when each phase began. The model gave an overall agreement of 89 (A_{model} = 88.6 and $A_{overall}$ = 89.6) **(Table 5.2.3; Figure 5.2.9).** It should be noted that one determination (UBA-12509: 1240 ±18 BP) on Maloideae charcoal from the posthole [1795] of Structure VII (Phase 3) had a slightly lower agreement index (A = 56.2%). It is retained however as it does not affect the overall agreement of the model. From this point, all modelled posterior dates are presented in italics.

Incorporating the two dates for the earliest medieval activity at the site, the construction of Enclosure B [C9] (Poz-25204, 400-560 AD (C63); UBA-10015, 646-772 Cal. AD (C165)), the model has constrained the earliest phase of early medieval activity to *551-630 AD (68% probability)* or *496-644 AD (95% probability).* While this provides a *terminus post quem* for the construction of the ditch, the tail of distribution from the later date (UBA-10015, 646-772 Cal. AD) from another basal layer of the ditch (C165) suggests partial cleaning of the ditch was being carried out while the primary fills were accumulating. This is supported by the truncation of [C9] by hearth [C131] (UBA-12501) cut into the ditch, which dated to *684-725 AD (68% probability)* or *678-766 AD (95% probability)* The model also refined the date for Structure IV (UBA-12507), a roundhouse located just outside the enclosure to the north, giving a posterior of *428-614 AD (68% probability)* or *545-645 AD (95% probability)* making it contemporary with the earliest phase of the Enclosure B.

Table 5.2.2 Radiocarbon dates from Twomileborris, Co. Tipperary (AR31/AR33)

Site	Laboratory code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Context no.	Context	Material dated	Material species identification
AR33	Poz-25204	1540	1580	35	400	560	C63	Basal fill of Enclosure B	Animal bone	Tibia fragment
AR33	UBA-12507	1516	29	433	614	-24.2	C1971	Single fill of wall slot of structure VI in interior of enclosure C	Charcoal	Quercus sp.
AR33	UBA-10018	1413	29	591	664	-23.7	C868	Linear feature [814]	Animal bone	Not specified
AR33	UBA-12495	1337	22	648	765	-27.0	C785	Single fill of wall slot of structure I [787] interior of enclosure A	Charcoal	Fraxinus excelsior
AR33	UBA-10016	1327	28	650	769	-20.5	C31	Basal fill of enclosure C [5]	Animal bone	Cattle metatarsal
AR33	UBA-10015	1329	36	646	772	-28.1	C165	Basal fill of enclosure B	Animal bone	Humerus fragment
AR33	UBA-12502	1300	2	662	771	-26.3	C1148	Lower fill of kiln C [1145] north of Enclosure A	Charred cereal grain	Hordeum sp.
AR33	UBA-9100	1275	20	677	774	-28.7	C549	Basal fill of enclosure A [546]	Animal bone	Tibia
AR33	UBA-12501	1272	18	680	774	-26.1	C0131	Single fill of smithing hearth cut [130] into top of Enclosure B ditch	Charcoal	Quercus sp.
AR33	UBA-12504	1257	23	673	856	-26.7	C2074	Middle fill of charcoal rich pit [2071] to north of enclosure A	Charred cereal grain	Hordeum sp.
AR33	UBA-10017	1241	28	686	870	-21.7	C874	Basal fill of linear [864]	Animal bone	Not specified
AR33	UBA-12509	1240	18	688	866	-25.7	C1796	Posthole [1795] from structure VII, interior enclosure C	Charcoal	Maloideae spp.
AR33	UBA-12500	1213	23	717	887	-25.9	C933	Basal fill of metalworking feature [882]	Charred cereal grain	Avena sp.
AR33	UBA-12496	1209	25	724	887	-25.0	C2036	Basal fill of roasting pit [2036], interior Enclosure B	Charred cereal grain	Hordeum sp.
AR33	UBA-12505	1165	18	779	947	-26.7	C1416	Single fill of wall slot [1415] of structure 5 in interior of enclosure B	Charcoal	Betula sp.

Site	Laboratory code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Context no.	Context	Material dated	Material species identification
AR33	UBA-12503	1124	18	887	976	-23.1	C1248	Basal fill of stone lined pit [1245] (associated with metalworking complex)	Charred cereal grain	Hordeum sp.
AR33	UBA-12497	1101	22	892	989	-23.0	C193	Middle fill of ditch, enclosure C [5] south	Charred cereal grain	Triticum sp.
AR33	UBA-12499	1045	21	905	1024	-26.1	C637	Basal fill of the conjoined pits [436] to south of Enclosure C	Charred cereal grain	Hordeum sp.
AR33	UBA-12498	1039	21	973	1025	-24.8	C921	Basal fill from kiln B [920], in interior of enclosure C	Charred cereal grain	Hordeum sp.
AR33	UBA-12570	960	23	1032	1162	-21.0	C1009	Skeleton Burial 4	Human bone	Collagen
AR33	UBA-12569	925	23	1021	1154	-20.3	C1011	Skeleton Burial 5	Human bone	Collagen
AR33	UBA-12508	907	21	1039	1205	-25.8	C752	Single fill of wall slot [751] of structure II in interior of enclosure A	Charcoal	Fraxinus excelsior
AR31	UBA-12878	840	28	1156	1262	-15.3	C662	Basal fill of kiln [660]	Charred cereal grain	Triticum sp.
AR31	UBA-12882	768	29	1219	1280	-16.7	C3356	Floor surface of structure [3305]	Charcoal	Salix sp.
AR31	UBA-12876	622	31	1291	1399	-26.3	C539	Basal fill of metalworking pit [537]	Charcoal	Fraxinus excelsior
AR31	UBA-12877	598	27	1298	1408	-21	C2708	Fill of kiln [1758]	Charred cereal grain	Triticum sp.
AR31	UBA-12879	377	23	1447	1629	-16.9	C191	Basal fill of kiln [91]	Charcoal	Prunus spinosa
AR31	UBA-12875	358	28	1452	1634	-23.6	C2014	Fill of smithing hearth [2043]	Charcoal	Corylus avellana
AR31	UBA-12873	306	22	1495	1648	-27.3	C1441	Fill of circular structure [1440]	Charcoal	Corylus avellana
AR31	UBA-12874	260	28	1521	1951	-25.7	C1022	Fill of circular structure [1021]	Charcoal	Corylus avellana
AR31	UBA-12872	241	23	1636	1951	-26.4	C2133	Fill of rectangualr ditch [2132]	Charred cereal grain	Hordeum sp.

Site	Laboratory code	Estimated felling date	No. of rings	Start year	End year	Content no.	Context	Material dated	Material species identification
AR31	Q11037	After 1208AD	279	898AD	1176AD	Timber 5	Timber in wheel pit beside tail race	Wood	Quercus sp.
AR31	Q11041	After 1188AD	223	934AD	1156AD	Timber 8	Timber in wheel pit	Wood	Quercus sp.
AR31	Q11042	After 1118AD	147	940AD	1086AD	Timber 19	Plank from sluice area of mill	Wood	Quercus sp.

The transition from Phase 1 (Enclosure B) to Phase 2 (Enclosure A and associated structure, hearths and corn drying kilns) is likely to have occurred between *728-793 AD (68% probability)* or *706-824 AD (95% probability)*. This enclosure was in use until the later expansion of the site (Enclosure C and cemetery) (Phase 3) which is predicted to have taken place between *875-1002 AD (68% probability)* or *819-1013 AD (95% probability)*, with a cessation of activity projected as being between *1063-1254 AD (68% probability)* or *1043-1248 AD (95% probability)*. The early medieval settlement activity recorded at Borris was continuous with a successive phasing of enclosure construction, habitation and industrial activity, with a later cemetery spanning from the approx. the sixth to the late twelfth century AD **(Figure 5.2.10).**

Table 5.2.3 Modelled posterior dates from Borris (AR33)

Twomileborris AR33 [E2376]	**Unmodelled (AD) 68%**			**Modelled (AD) 95%**			**Model index**	**Index Agreement (A'c = 60.0%)**
	from	**to**	**%**	**from**	**to**	**%**		
Model Agreement (Amodel) = 88.6								
(Aoverall) = 89.6								
Sequence Twomileborris AR33								
Boundary Start Phase 1 Enclosure B	551	630	68.2	496	644	95.4		95.6
Phase Phase 1 Enclosure B								
R_Date UBA-12495	647	764	68.2	647	761	95.4	101.5	99.8
R_Date UBA-12502	668	764	68.2	667	763	95.4	100.6	99.8
R_Date UBA-12504	672	860	68.2	680	770	95.4	106.8	99.8
R_Date UBA-12501	679	770	68.2	678	766	95.4	99.4	99.9
R_Date UBA-10017	684	876	68.2	679	775	95.4	117.1	99.7
After	546.5	...	68.2					
R_Date Poz-25204	403	554	68.2	403	555	95.4	99.8	99.5
R_Date UBA-9100	675	770	68.2	675	766	95.4	99.3	99.9
R_Date UBA-10015	646	769	68.2	646	766	95.4	103.4	99.7
R_Date UBA-12507	428	614	68.2	546	645	95.4	66.3	97
R_Date UBA-12503	886	977	68.2	886	977	95.4		99.6
R_Date UBA-12506	-204	-57	68.2	-205	-57	95.4		99.2
Boundary Phase 1 Enclosure B_Phase 2 Ringfort	728	793	68.2	706	824	95.4		99.7
Phase Phase 2 Ringfort Enclosure A								
R_Date UBA-12498	975	1025	68.2	976	1026	95.4		99.6
R_Date UBA-12509 (Poor agreement 56.8)	687	869	68.2	727	877	95.4	56.8	99.6
R_Date UBA-12496	718	889	68.2	770	883	95.4	107.2	99.6
R_Date UBA-12500	720	886	68.2	769	881	95.4	106.7	99.7
R_Date UBA-12505	775	946	68.2	775	940	95.4	97.8	99.5
After	760	...	68.2					
R_Date UBA-10016	650	767	68.2	650	767	95.4	99.7	99.7
After	657	...	68.2					

R_Date UBA-10018	589	664	68.2	589	664	95.4	99.5	99.8
Boundary Phase 2 Ringfort_Phase 3 Enclosure C/ Cemetery	875	1002	68.2	819	1013	95.4		98.8
Phase Phase 3 Enclosure C and Cemetery								
R_Date UBA-12499	970	1025	68.2	975	1025	95.4	102.3	99.8
R_Date UBA-12508	1039	1185	68.2	1032	1162	95.4	107.8	99.6
R_Date UBA-12569	1035	1160	68.2	1028	1143	95.4	99.8	99.6
R_Date UBA-12570	1021	1155	68.2	1020	1147	95.4	100.5	99.6
R_Date UBA-12493	975	1025	68.2	979	1025	95.4	101.3	99.8
After	986.5	...	68.2					
R_Date UBA-12497	891	990	68.2	892	991	95.4	99.3	99.6
Boundary End Phase 3	1063	1164	68.2	1043	1248	95.4		96.3

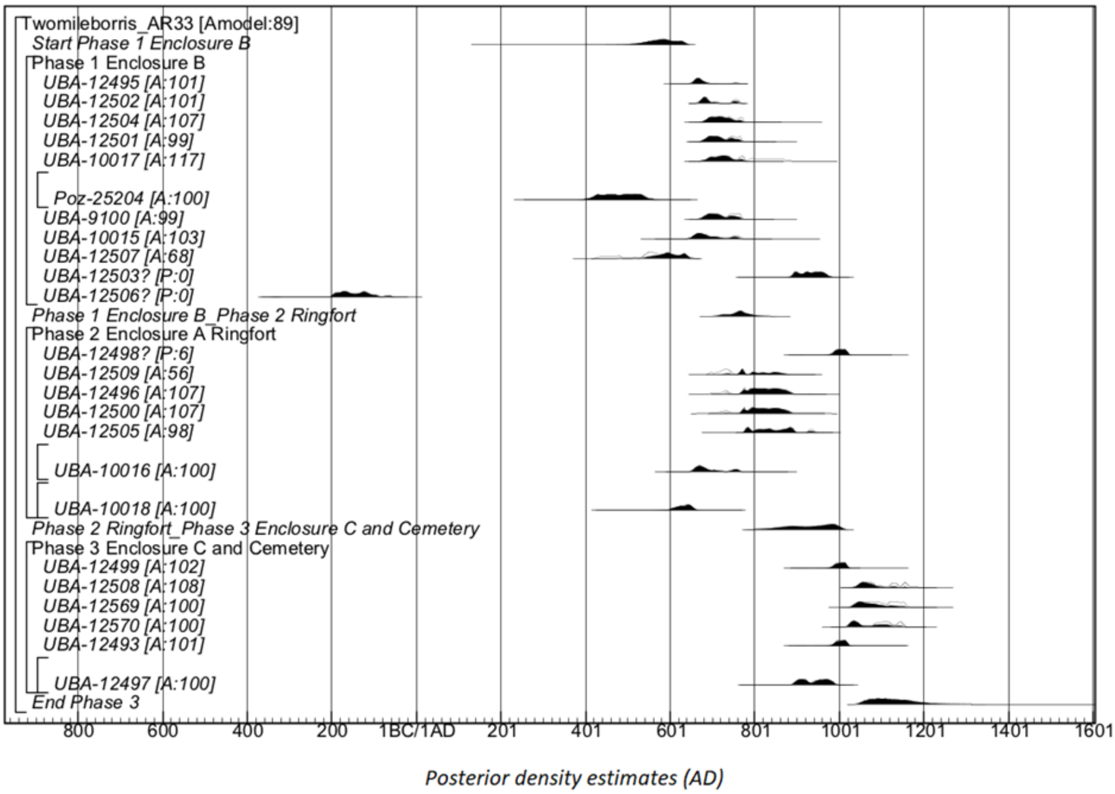


Figure 5.2.9 Probability distribution of dates for Borris (AR33)

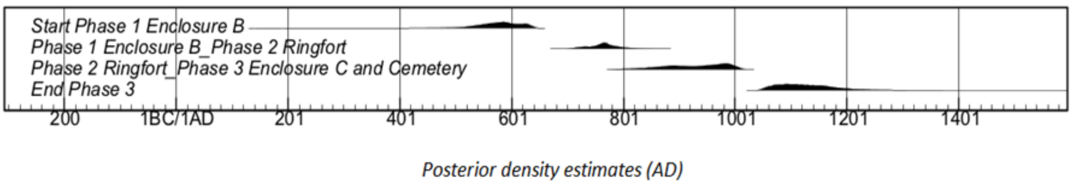


Figure 5.2.10 Probability distribution of main phases at Borris (AR33)

Late medieval settlement complex (AR31)

Nine radiocarbon dates and 3 dendrochronological dates were used to construct a Bayesian model for the late medieval settlement at AR31 located just c.400m to the northwest. The model gave an overall agreement of 89 (A_{model} = 89.5 and $A_{overall}$ = 89.6) **(Table 5.2.4; Figures 5.2.11, 5.2.12).** One determination (UBA-12509: 1240 ±18 BP) from the posthole [1795] of Structure VII (Phase 3) had a slightly lower agreement index (A = 56.8%). It is retained as it does not affect the overall agreement of the model.

The results from the Bayesian modelling for the later medieval settlement complex generated a start date or *terminus post quem* of *571-1253 AD (95% probabililty)* or most likely *1044-1237 AD (68% probability),* which suggests that the settlement at AR31 commenced at the same time AR33 to the east began to cease. The earliest phase of activity at AR31 was characterised by a mill structure, which produced a felling date of 1118 AD [Timber 19; Q11042]. This was followed soon after by the construction of a second mill approx. 20m north, which produced two felling dates of 1188 AD (Timber 8; Q11041) and 1208 AD (Timber 5; Q11037); a corn drying kiln [660] (UBA-12878) located approx. 30m to the east and a small rectangular building [3305] (UBA-12882) just 10m to the west of the mill complex. The kiln date was remodelled and produced a posterior of *1208-1260 AD (68% probability)* or *1173-1267 AD (95% probability),* while a posterior dated the structure to *1244-1277 AD (68% probability)* or *1221-1282 AD (95% probability).*

The remains of a metalworking area, situated between the kiln and mill complex seems to have commenced slightly later, where pit [537] (UBA-12876) generated a posterior of *1288-1318 AD (68% probability) or 1280-1361 AD (95% probability).* By constraining all these dates together, the model projected that the second mill complex, the kiln and building activity commenced at *1175-1250 AD (68% probability)* or *1125-1256 AD (95% probability)* and ended with the metalworking activity at *1295-1349 AD (68% probability)* or *1289-1390 AD (95% probability).* A second corn drying kiln phase, defined by kiln [1758] (UBA-12877) produced a posterior of *1337-1407 AD (68% probability)* or *1315-1412 AD (95% probability).* Another industrial phase commenced thereafter with a third phase of corn drying [91] (UBA-12879) and a series of metalworking in the form of smithing [2043]

(UBA-12875) and a circular structure [1440] (UBA-12873). The remodelled dates for this phase produced posteriors of *1530 AD (68% probability)* or *1463-1673 AD (95% probability).* The end of this continuous settlement is predicted to have ceased no later than *1694 AD (95% probability)* or most likely *1655-1694 AD (68% probability).*

Table 5.2.4 Modelled posterior dates from Borris/Blackcastle (AR31)

Twomileborris AR31 [2374]	**Unmodelled (AD) 68.2%**			**Modelled (AD) 95.4%**			**Model index**	**Index Agreement (A'c = 60.0%)**
	from	**to**	**%**	**from**	**to**	**%**		
Model Agreement (Amodel) = 89.5								
(Aoverall)= 89.6								
Sequence Twomileborris AR31								
Boundary Start Twomileborris AR31	1044	1237	68.2	571	1253	95.4		98
Sequence Twomileborris AR31								
Phase Phase_1_Watermill								
After	1118	...	68.2	1118	…	95.4		
C_Date Q11042	1117	1118	68.2	1117	1118	95.4	100	100
Sequence								
Boundary Start Phase_2_Kiln activity	1175	1250	68.2	1125	1256	95.4		99.6
Phase Phase_2_Kiln activity								
After	1208	...	68.2	1208	…	95.4		
C_Date Q11037	1207	1208	68.2	1207	1208	95.4	100	100
After	1188	...	68.2	1188	…	95.4		
C_Date Q11041	1187	1188	68.2	1187	1188	95.4	100	100
Phase kiln								
R_Date UBA-12878	1208	1260	68.2	1173	1267	95.4	85.7	99.7
Phase subfloor								
R_Date UBA-12876	1288	1318	68.2	1280	1361	95.4	93.4	99.7
Phase floor level								
R_Date UBA-12882	1244	1277	68.2	1221	1282	95.4	103.5	99.9
Boundary End Phase_2_Kiln activity	1295	1349	68.2	1289	1390	95.4		99.7
Phase Phase_3_Metal_working_smithy								
Phase kiln								
R_Date UBA-12877	1337	1407	68.2	1315	1412	95.4	96	99.7
Sequence								
Boundary Start Phase_4_Industrial	1523	1621	68.2	1420	1627	95.4		95.8
Phase Phase_4								
Phase kiln								
R_Date UBA-12879	1593	1621	68.2	1462	1635	95.4	84	99
Phase ditch basefill C2133								
R_Date UBA-12872	1530	...	68.2	1636	1673	95.4	114.4	99.7
Phase ditch gully C1441								
R_Date UBA-12873	1548	1648	68.2	1522	1651	95.4	93.9	99.1
Phase circular ditch C1022								
R_Date UBA-12874	1648	...	68.2	1640	1790	95.4	95.3	99.5

Phase basal fill hearth C2044								
R_Date UBA-12875	1548	1634	68.2	1479	1643	95.4	100.5	98.6
Boundary End Phase_4_Industrial	1655	1694	68.2	1646	1806	95.4		98.7

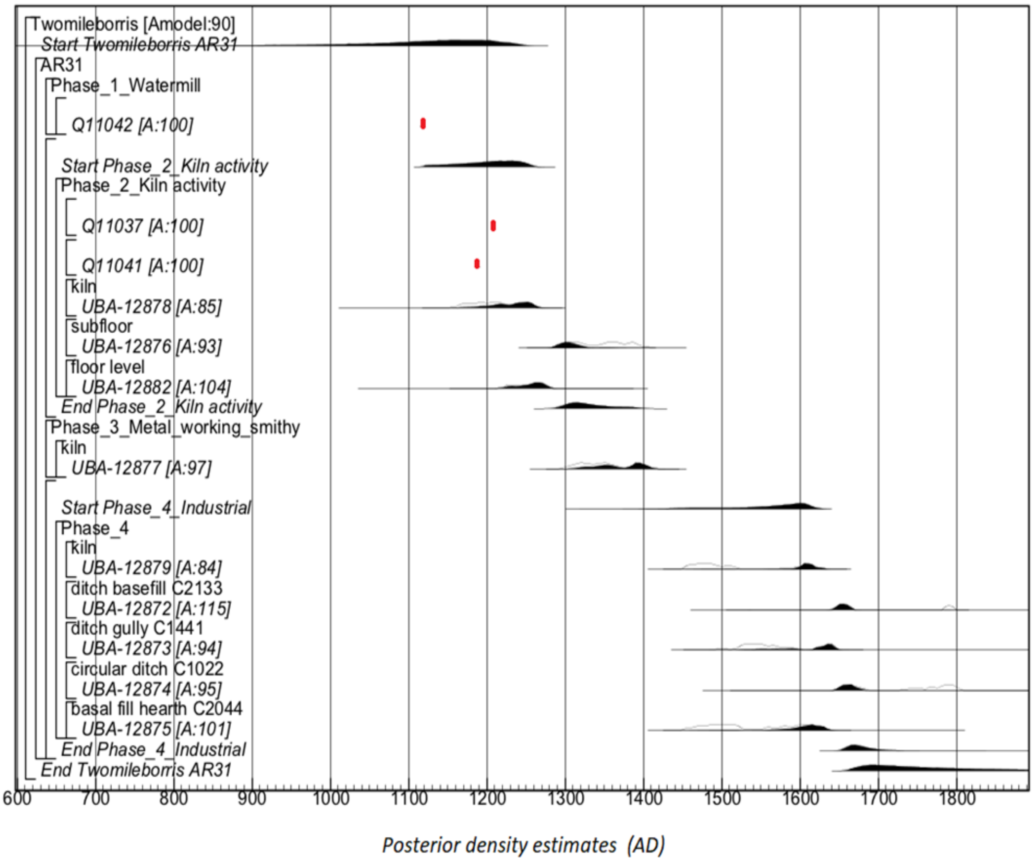


Figure 5.2.11 Probability distribution of dates from Borris/Blackcastle (AR31) (Dendrochronological dates are marked in red)

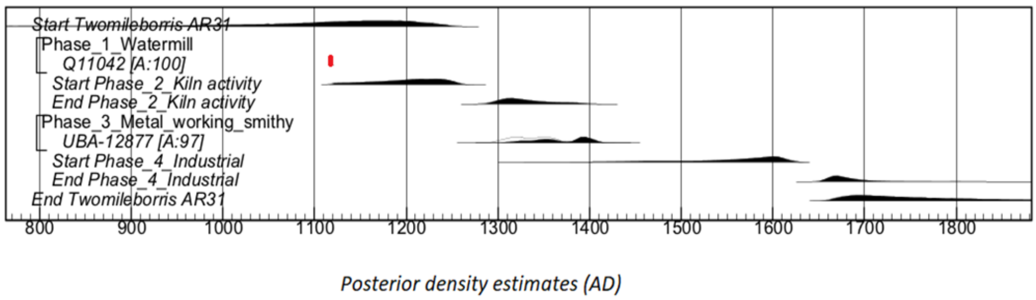


Figure 5.2.12 Probability distribution of main phases at Borris/Blackcastle (AR31) (Dendrochronological dates are marked in red)

5.2.4 Charcoal results from Twomileborris (AR31/AR33)

Nine wood taxa totalling 2032 charcoal identifications were recorded from the charcoal samples associated with the early and later medieval settlement activity at AR31 and AR33. The assemblage was dominated by *Quercus* sp. accounting for 45% (894 counts) of the assemblage followed by *Corylus avellana* at 27% (548 counts). Pomaceous woods (Maloideae spp.) made up 14% (284 counts), *Salix* sp. 8% (162 counts) and *Euonymus europaeus* 4% (81 counts). Lower occurrences of *Fraxinus excelsior*, *Prunus* sp., *Taxus baccata* and *Alnus glutinosa* accounted for 1% or less (<20 counts) of the overall assemblage **(Figure 5.2.13).**

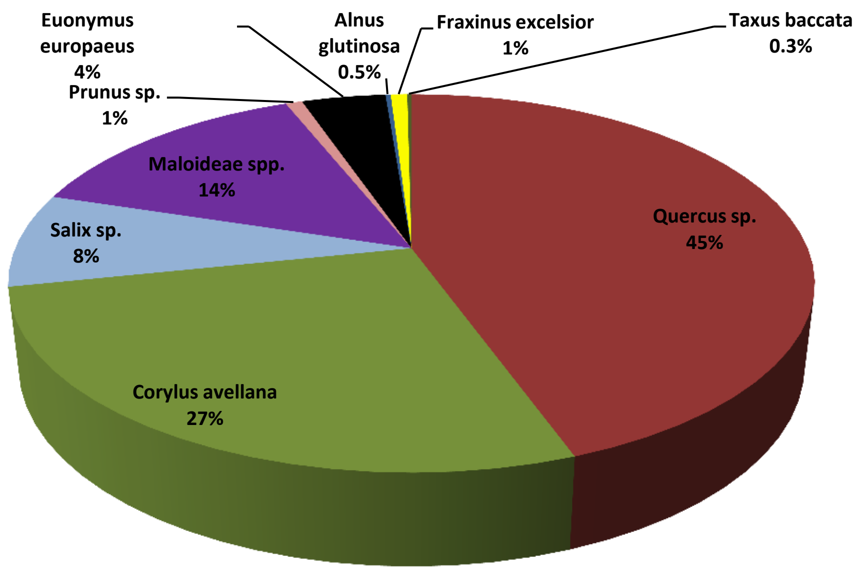


Figure 5.2.13 Percentage of wood taxa from Twomileborris (n = 2032)

When the results are plotted to show the comparison between the early medieval settlement (AR33) and the later medieval settlement (AR31), some notable differences are apparent. While oak values remain similar between the two phases of settlement there is an increase in hazel on the late medieval settlement complex, while Maloideae wood species decline in the later period. Willow increases in the later medieval period, while ash, alder and *Prunus* woods are all but absent from this phase. Spindle, albeit low remains a presence on the later settlement and there is evidence for yew on AR31 **(Figure 5.2.14).**

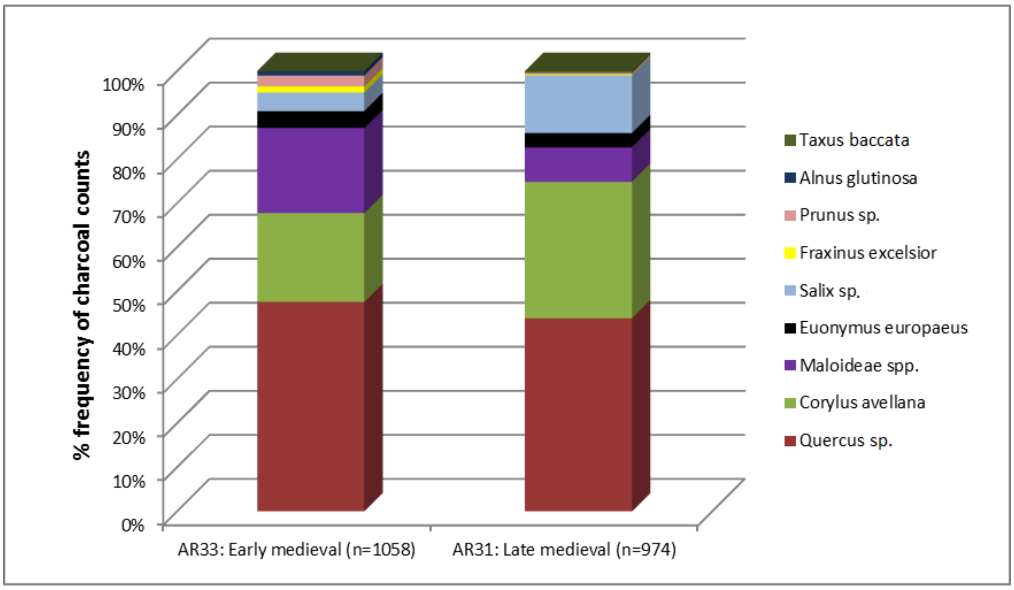


Figure 5.2.14 Distribution of wood taxa from AR31 and AR33

Chronological changes to wood taxa from Twomileborris

The chronology of activity at Twomileborris, now refined through Bayesian in-depth modelling, allows for the wood taxa from each phase of activity to be examined and compared more confidently. The results are discussed in phases (Phases 1-5) in line with the archaeological and radiocarbon dating sequences. Phases 1-3 are characterised by the early medieval settlement complex on AR33 and Phase 4 and Phase 5 define the late medieval settlement on AR31.

Phase 1

The earliest phase of medieval activity at AR33, defined by Enclosure B was postulated as having a *terminus post quem* of *496-644 AD* (*95% probability*), with a contemporary structure (Structure VI) dating to *546-645 AD (95% probability*). A series of roasting pits associated with this phase were also identified. Oak dominated in the ditch, Structure VI (slot trench) and pit features from this phase, ash and hazel values were low and confined to postholes from Structure VI [1423], a number of roasting pits [2015 and 2033] and ditch deposits. Maloideae woods and spindle were also present, although in low frequencies (<2%) and largely found in the pit and ditch fills **(Figure 5.2.15).**

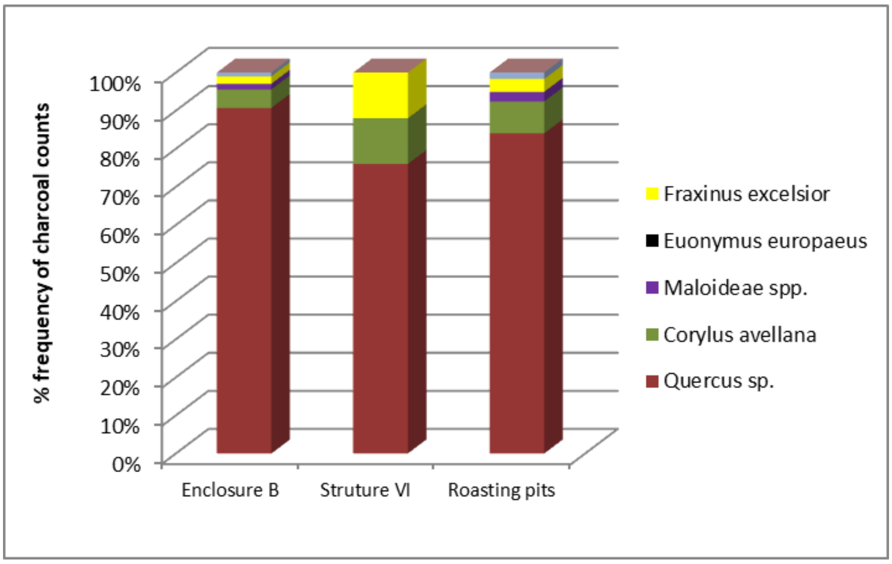


Figure 5.2.15 Distribution of wood taxa from Phase 1: Enclosure B (n = 318)

Phase 1/2 and Phase 2

Structure I was dated to the intervening period between the end of Phase 1 and beginning of Phase 2 *(647-761 AD; 95% probability)*. Here, oak was the main wood taxa recorded from posthole deposits, with a lower frequency of hazel and Maloideae woods. Phase 2, which commenced c.*706-824 AD (95% probability)* was defined by the construction of the ringfort (Enclosure A).

The wood taxa identified were notably different to activity from the preceding Enclosure B phase. The frequency of hazel and Maloideae woods were significantly higher overall, with oak common in corn drying kiln [1145], Structure VII and unsurprisingly in features associated with smithing and iron working [130]. Ash was the prominent wood taxa from postholes associated with Structure V and willow, alder and spindle also appear in ditch, kiln and domestic pits **(Figure 5.2.16).**

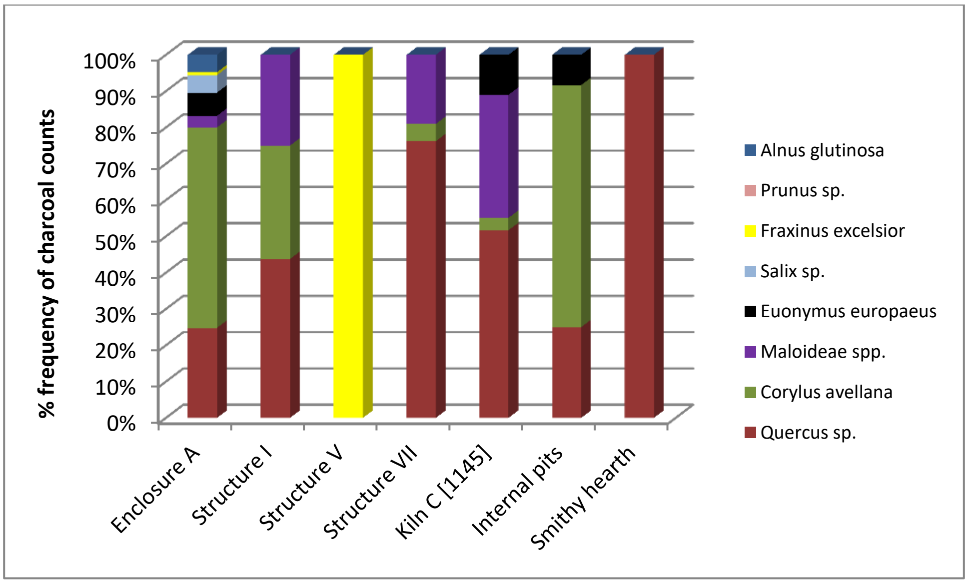


Figure 5.2.16 Distribution of wood taxa from Phase 2: Enclosure A (n = 360)

Phase 3

Enclosure A was later enlarged in addition to being modified into a rectilinear enclosure (Enclosure C), which included working areas such as corn dying kilns [525 and 920], further metalworking activity and a cemetery. This phase was projected to have commenced c. *819-1012 AD (95% probability)* and continued until c. *1043-1248 AD (95% probability).*

The composition of wood taxa again differed from earlier phases. While oak remains high from metalworking features [882, 1245, 1554 and1637], its frequency in corn drying kilns [525 and 920] and ditch fills is lower than the preceding periods of the settlement. Ash is again the wood found in postholes associated with Structure II [751], albeit in a lower frequency. Maloideae woods remain constant if not higher from the previous phase, with an increase in willow, alder, spindle and cherry-wood more apparent from ditch fills (Enclosure C), kiln [920] and domestic rubbish pits [436 and 1662] **(Figure 5.2.17).**

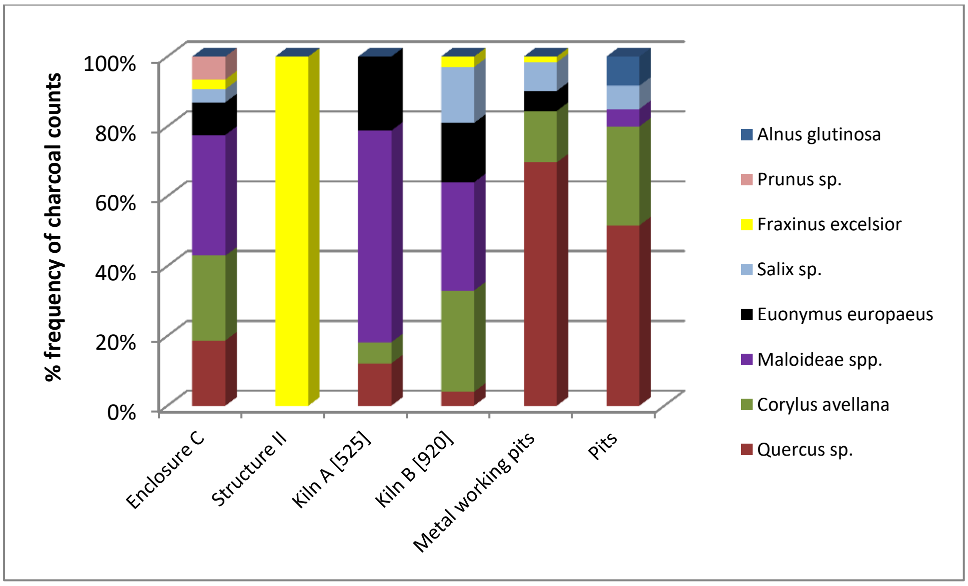


Figure 5.2.17 Distribution of wood taxa from Phase 3: Enclosure C (n = 322)

Phase 4/Phase 5

As AR33 ceased occupation, Phase 4 and Phase 5 is characterised by the settlement and industrial complex on Site AR31, situated c.400m to the northwest, which dated from the twelfth to post-fifteenth century AD. The earliest activity (Phase 4) was defined by two watermills, constructed of oak, a small structure [3005] 10m to the west and a corn drying kiln [660] to the east projected as dating to *1125-1256 AD (95% probability).* In addition, a series of metalworking features [306, 489 and 537] located to the east of the mill complex dated slightly later to *1289-1390 AD (95% probability).* Oak and hazel charcoal dominated the kiln deposits, suggesting that these were the main taxa used in this feature.

In contrast, the contemporary structure [3005] contained a notable frequency of willow, perhaps reflecting the taxon used in part of its construction, suggesting a light construct such as wattling A lower frequency of spindle and oak charcoal from floor deposits may be incidental, brought into the building inadvertently as redeposited material from domestic activities. Oak is highest from features associated with metalworking activity [306, 489 and 537], although a number of other taxa were also present. Hazel values are notable from furnace [306], while evidence, albeit low, for spindle, ash and Maloideae wood species are also found within these features. Interestingly, values for ash and Maloideae wood species have noticeably declined from Phase 3, while oak values are risen **(Figure 5.2.18).**

The charcoal assemblage from a later dated kiln [1758] *(1315-1412 AD; 95% probability)* (Phase 4/5) is dominated by Maloideae wood species, while oak values are lower than those found in kiln [660]. Hazel, willow and spindle were also present in kiln [1758]. Whether this reflects a decrease in oak at the site is difficult to ascertain based on just one feature and may not be a solid representation of wood resource use at the site during this period. As the settlement continues into the fifteenth and sixteenth century AD (Phase 5), there is a notable rise in hazel charcoal from the features dating to this phase *(1462-1673 AD).* This taxon dominates the smithy hearth [2043] and corn drying kiln [91] and is also present in low frequency from two circular structures [1021] and [1440].

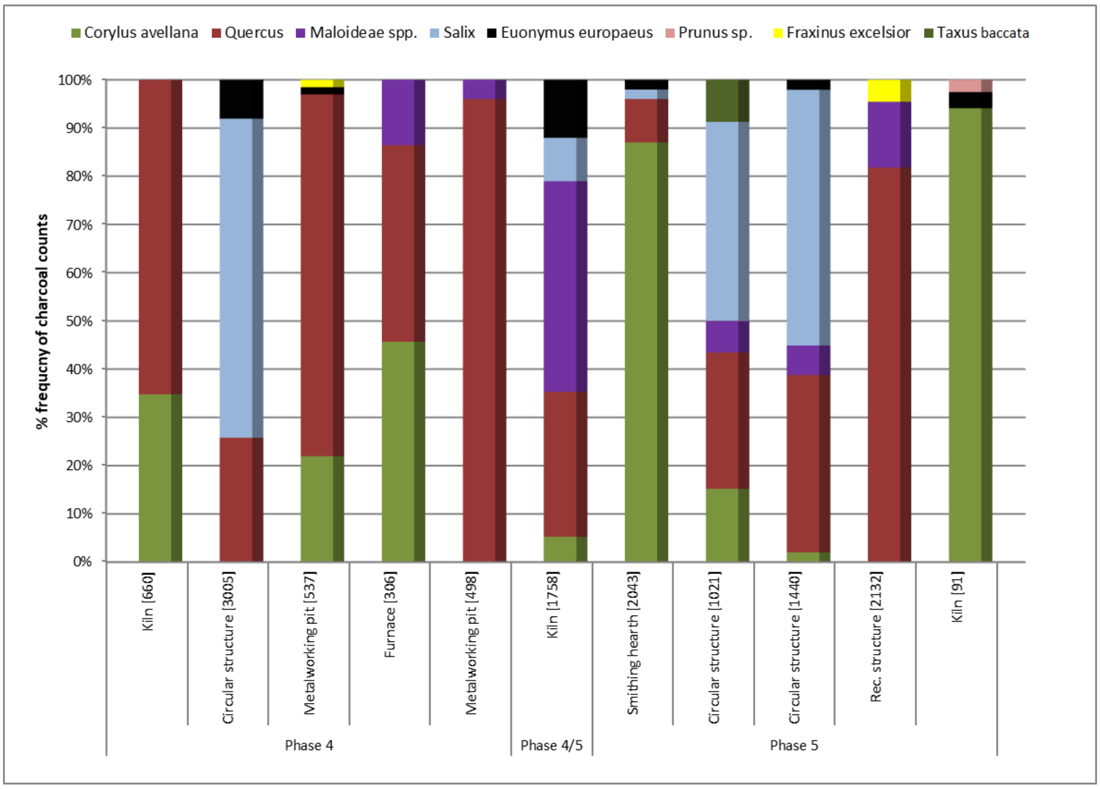


Figure 5.2.18 Distribution of wood taxa from Phase 4 and 5 (n = 974)

While oak values have declined overall from the Phase 4 activity, its presence, together with willow charcoal is highest from buildings [1021], [1440] and [2132], perhaps indicating its use in construction, since they were recovered from slot ditch [1022 and 1164] and posthole deposits [1101 and 1102]. Oak would have been suited for large posts, while willow may have been used in the construction of a light fence/wall of wattle. The number of fragments identified from [2132] was very low and may not be a true representation of the wood taxa from this feature, but instead reflects re-deposited debris from domestic waste. Maloideae wood species are also low and confined to both structures, while cherry-type and spindle may represent residual debris from on-site domestic activities

5.2.5 Overview of wood use at Twomileborris

The distribution of wood taxa recorded from the two settlement complexes at Twomileborris (AR31 and AR33) are presented in **Figure 5.2.19** below, which displays the variance of species recorded from the late fifth to post-fifteeenth century AD.

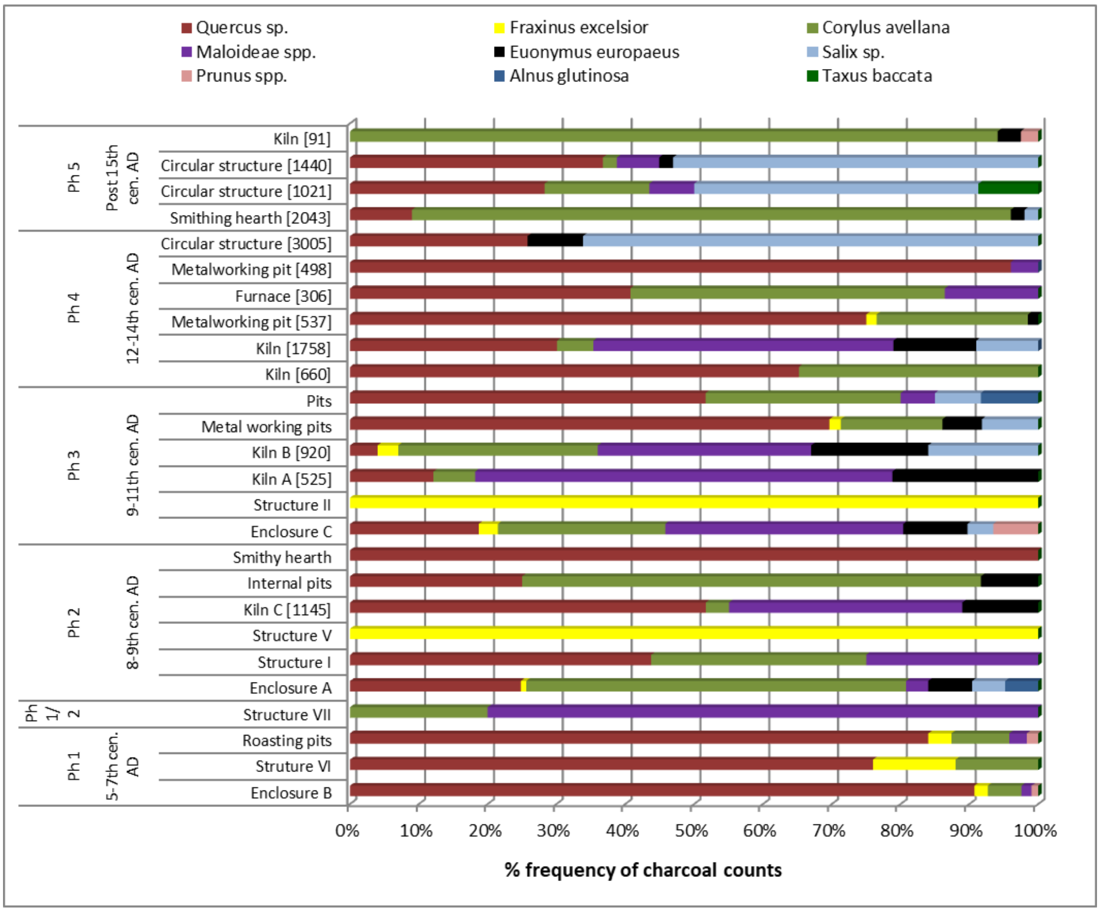


Figure 5.2.19 Distribution of wood taxa by phase at Twomileborris AR31/AR33 (n = 2032)

One of the most striking outcomes of the results from Twomileborris is the very low occurrence of ash from the charcoal assemblage, a taxon that is proving to be a significant component from early medieval charcoal records in this study and which was a common occurrence from contemporary activities at Hughes' Lot East and

Toureen Peckaun further south **(see Section 5.3).** The charcoal assemblage from the early medieval phases at AR33 (Phase 1-3) clearly shows that ash was not a major wood resource being used at the site, instead oak dominates from all three phases. Indeed, the only noticeable evidence for ash is from pre-eleventh century features, with the higher values recorded from between the eighth and ninth century AD **(Figure 5.2.20)**, however the ash dataset is too minor to be considered as representing a clear oak versus ash divide in this context. The early medieval settlement at Twomileborris therefore represents one of the key site types emerging from this study, where oak is the dominant wood taxa recorded across all features for the duration of settlement occupation.

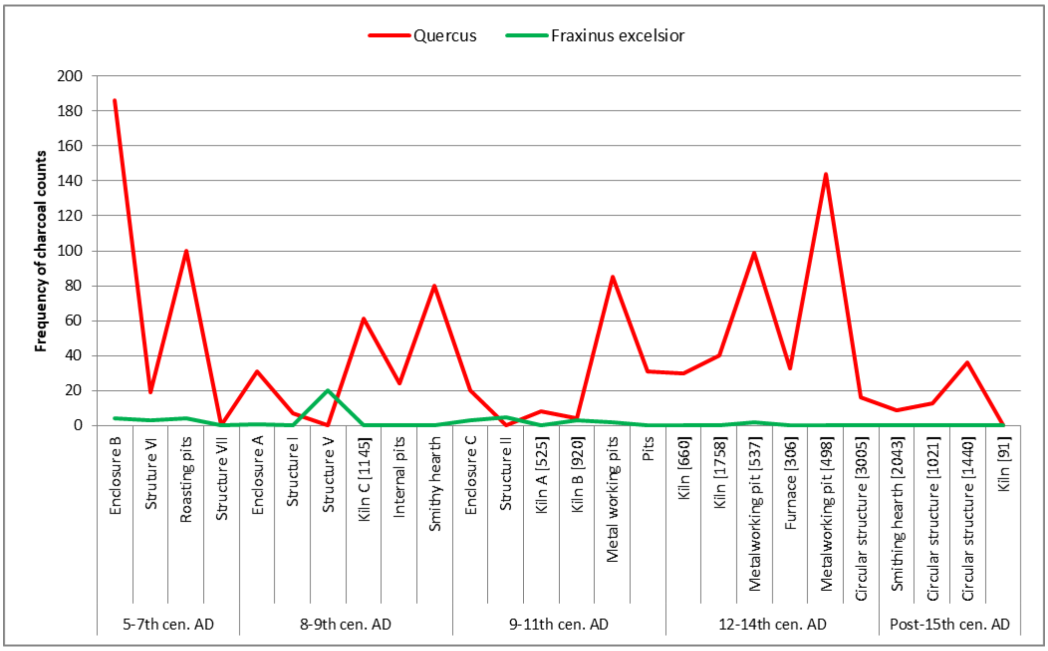


Figure 5.2.20 Comparisons between frequency of *Quercus* (oak) and *Fraxinus* (ash) from Twomileborris (n = 1123)

The main observations of wood taxa variance from the charcoal record is the high presence of oak at the site from the earliest settlement Phase 1 (Enclosure B) on AR33, which dates from c. *496-644 AD*. Wood signals such as ash and Maloideae begin to make an appearance during this period, and continue into Phase 2 (c.*706-824 AD* to c. *819-1012 AD)* as the settlement develops with the ringfort construction (Enclosure A). There is an increase in taxa variability, with spindle, willow and alder also appearing during this phase. When the ordination results for the site are reviewed, oak, which is strongly correlated to Phase 1 activity, has a weaker presence in Phase 2, which is probably a response to the rise in a more mixed wood assemblage being used, hence diluting the oak signal **(Figure 5.2.21).** With the exception of ash from Structure V, this taxon is altogether absent from all other features associated with Phase 2. This pattern continues into Phase 3 (c. *819-1012 AD* to *1042-1250 AD)*, where ash is again confined to Structure II, although values begin to see a decrease during this phase. Wood variability still exists, where taxa diversity is high (oak, hazel Maloideae, alder, willow and spindle) with wood, such as spindle being a notable occurrence in kilns [525] and [920] during this phase.

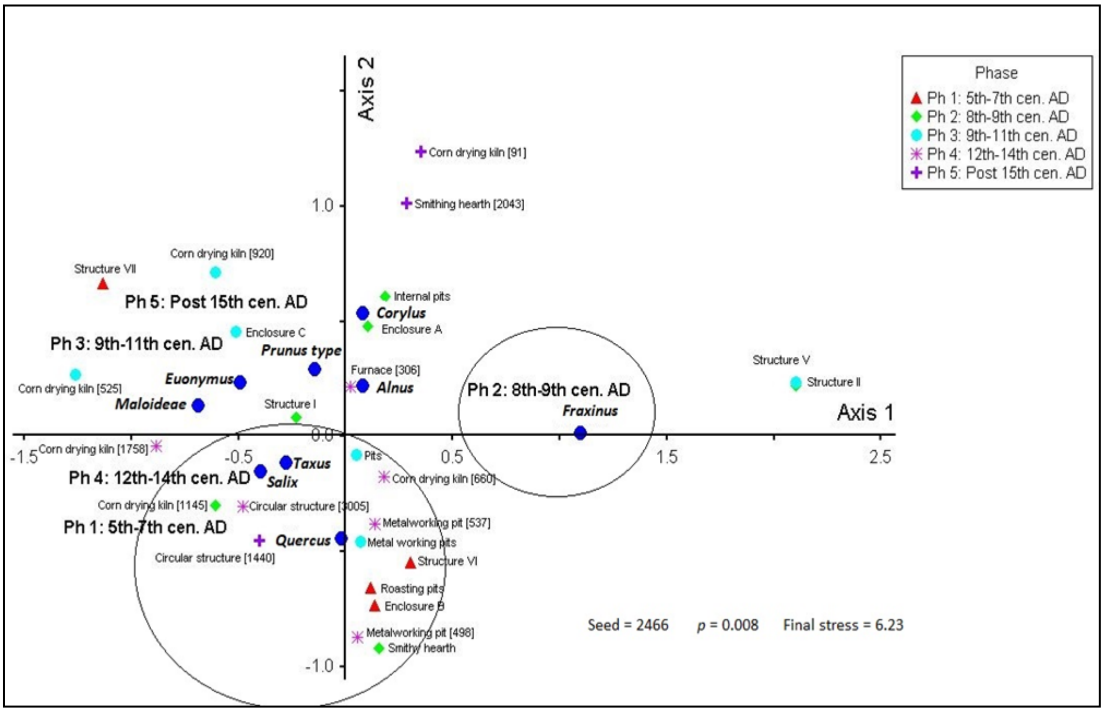


Figure 5.2.21 NMS ordination (Axis 1v 2) of wood taxa from Phase 1-5 at Twomileborris

During Phase 4 and 5, characterised by AR31 which commenced in the twelfth century *(1044-1237 AD)*, ash values are almost absent. Oak rises significantly during Phase 4 (*1125-1256 AD* to *1289-1390 AD)*, particularly from industrial features associated with metalworking and corn drying, but sees a decline in Phase 5 *(1462-1673 AD)*, as the settlement enters the fifteenth century AD. Hazel remains relatively constant throughout, with a notable increase in features from Phase 5. Maloideae wood species are also in decline from Phase 4/5, with the exception of kiln [1758], while willow is generally low from Phase 4 before increasing again in Phase 5 most notably from structures [1021] and [1440].

When the *r*-values in ordination are reviewed **(Table 5.2.5),** they show that ash and Maloideae woods are not found together or at the same time, most probably as ash is confined to Phase 2, with the fruitwood species more correlated to Phase 3 and Phase 5. The correlation between oak and hazel is interesting on Axis 2, which sees oak values rise as hazel values fall and vice versa. As both are prominent taxa found from each phase of the site, this suggests that they are not being used in the same way or at the same time. At a closer glance, hazel is more widely spread, correlated to structural, ditch and pit deposits from Phase 2, with oak confined to more industrial activities; kiln [1145] and features associated with smithing.

The use of other taxa, such as willow, alder, spindle, hazel, *Prunus* and Maloideae, interspersed with ash and oak during this phase also reduces the oak signal, which could indicate a period of relative decline in oak availability or usage at the site. During Phases 3 and 4 (late ninth to fourteenth century AD), hazel values decline while oak rises and is a notable presence from metalworking features, structures and kilns. This clearly demonstrates that oak is a scarce or selectively used resource at the site during the eighth and ninth century phase, which fits with the broader picture emerging during this period.

Table 5.2.5 Correlations (Pearson's *r*-value) of explanatory variables in NMS of wood taxa (Values in red are significant at the $p<0.05$ level for two tailed t-test)

Taxon	Axis 1 *r-value*	Axis 2 *r-value*	Axis 3 *r-value*
Fraxinus excelsior	**0.673**	0.007	0.24
Salix sp.	-0.265	-0.141	**-0.847**
Quercus sp.	-0.023	**-0.711**	0.266
Maloideae	**-0.576**	0.144	0.136
Corylus avellana	0.08	**0.7**	-0.008
Alnus glutinosa	0.032	0.111	-0.126
Prunus sp.	-0.069	0.184	0.14
Euonymus europaeus	-0.496	0.304	-0.11
Taxus baccata	-0.074	-0.042	-0.417

5.3 Hughes' Lot East, Cashel, Co. Tipperary (O'Brien 2014g, O'Brien 2014h, O'Brien 2014i)

The site at Hughes' Lot East, Co. Tipperary is situated in the townlands of Hughes'-Lot East and Kilscobin, approximately 2 km east of the medieval town of Cashel **(Plate 5.3.1; Figure 5.3.1).** The site encompasses three areas that were excavated in three separate lots - Site 25ii, Site 25iii and Site 25iv, all located less than 1 km apart running north (Site 25ii) to south (Site 25iv).

Plate 5.3.1 View west from Hughes' Lot East with the Rock of Cashel in the distance

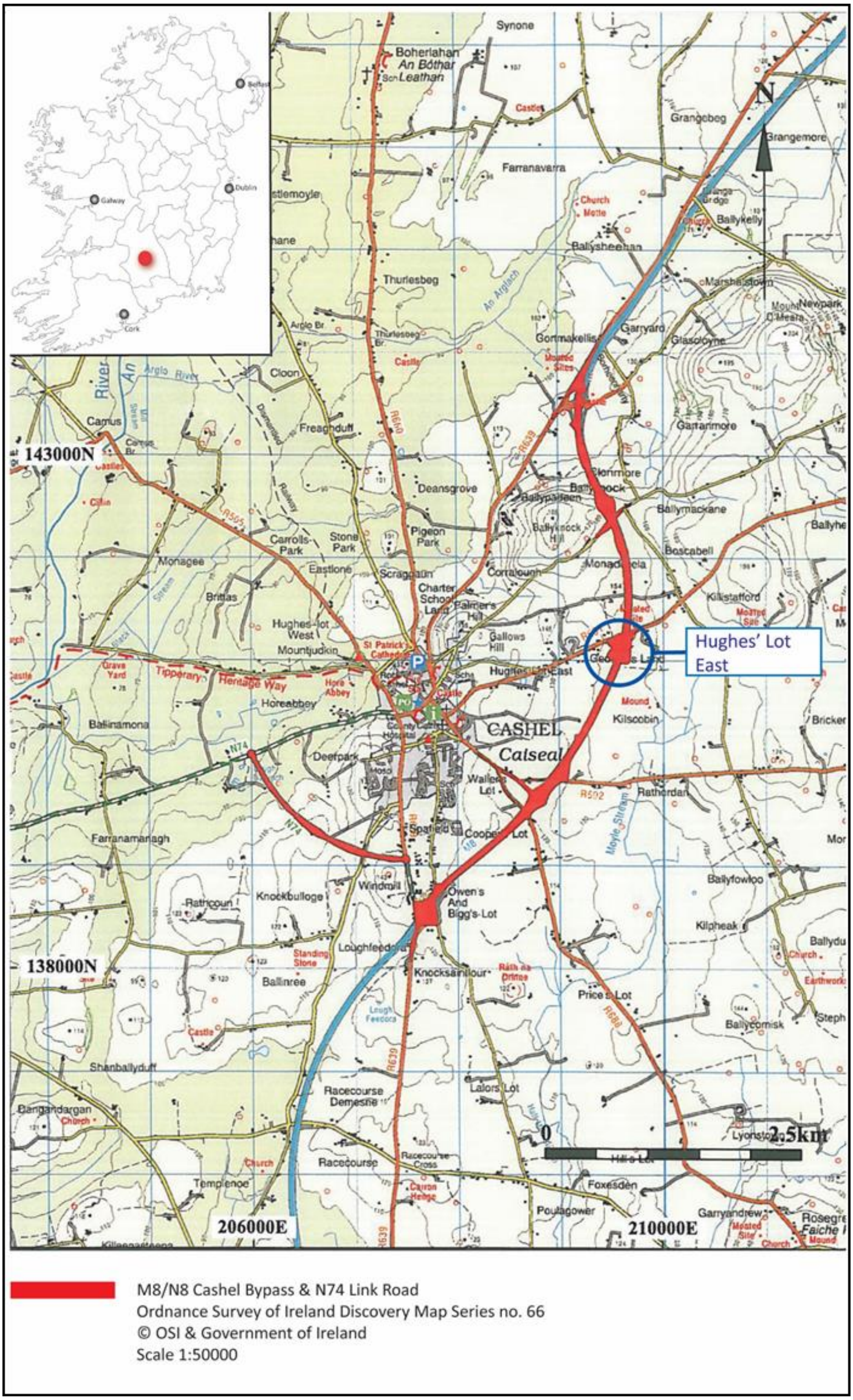


Figure 5.3.1 Location of Hughes' Lot East, Co. Tipperary

5.3.1 Historical background

The townland name Hughes'-Lot East may be related to the Corporation Lands of Cashel as the name does not appear on the Civil Survey for County Tipperary. The ordnance Survey Namebooks record the name in English without an explanation (O'Brien 2014g). The historic background of the Hughes' Lot East mirrors the political climate of the times: beginning - along with the Site 25iv ringfort to the south and expanding north to Site 25ii - as part of a complex of two Eóganacht Chaisil fortified settlements in the sixth century AD. The settlement expanded and underwent alterations throughout the centuries until into the eleventh century AD, when the ringfort ditches no longer functioned in a defensive capacity. By the twelfth century AD the larger and more complex Site 25ii ringfort had been abandoned and decommissioned, with the construction of the double-ditched parish boundary across the monument (ibid.). The settlement was lost to memory perhaps as early as the medieval period and the lands became part of the Liberties of Cashel throughout the English occupation of Cashel. The nearby *Trícha Cét* boundary currently has no archaeological status and therefore no protection.

5.3.2 Archaeological background

Prior to the archaeological excavations at Hughes' Lot East, there were no recorded archaeological monuments (RMP) sites listed for the site, except for the medieval town of Cashel itself (TI061-025) and an unexcavated enclosure (TI061-132) in the very north of the townland. The absence of upstanding monuments south of Cashel, apart from the ancient roadway *Rian Bó Phádraig* (TI061-071) suggests massive land clearance either during the Corporation's tenure (O'Brien, 2011).

The archaeological excavations were divided into three main areas of interest, in line with the results from initial archaeological testing along the road corridor - Site 25ii, Site iii and Site iv, located less than 1 km apart, running north (Site 25ii) to south (Site 25iv) **(Plate 5.3.2).** Based on the stratigraphical phases and radiocarbon dating programme, there were five main phases of activity recorded (O'Brien, 2011) **(Figure 5.3.2)**

Plate 5.3.2 View south showing Site 25ii with Sites 25iii & 25iv in the distance

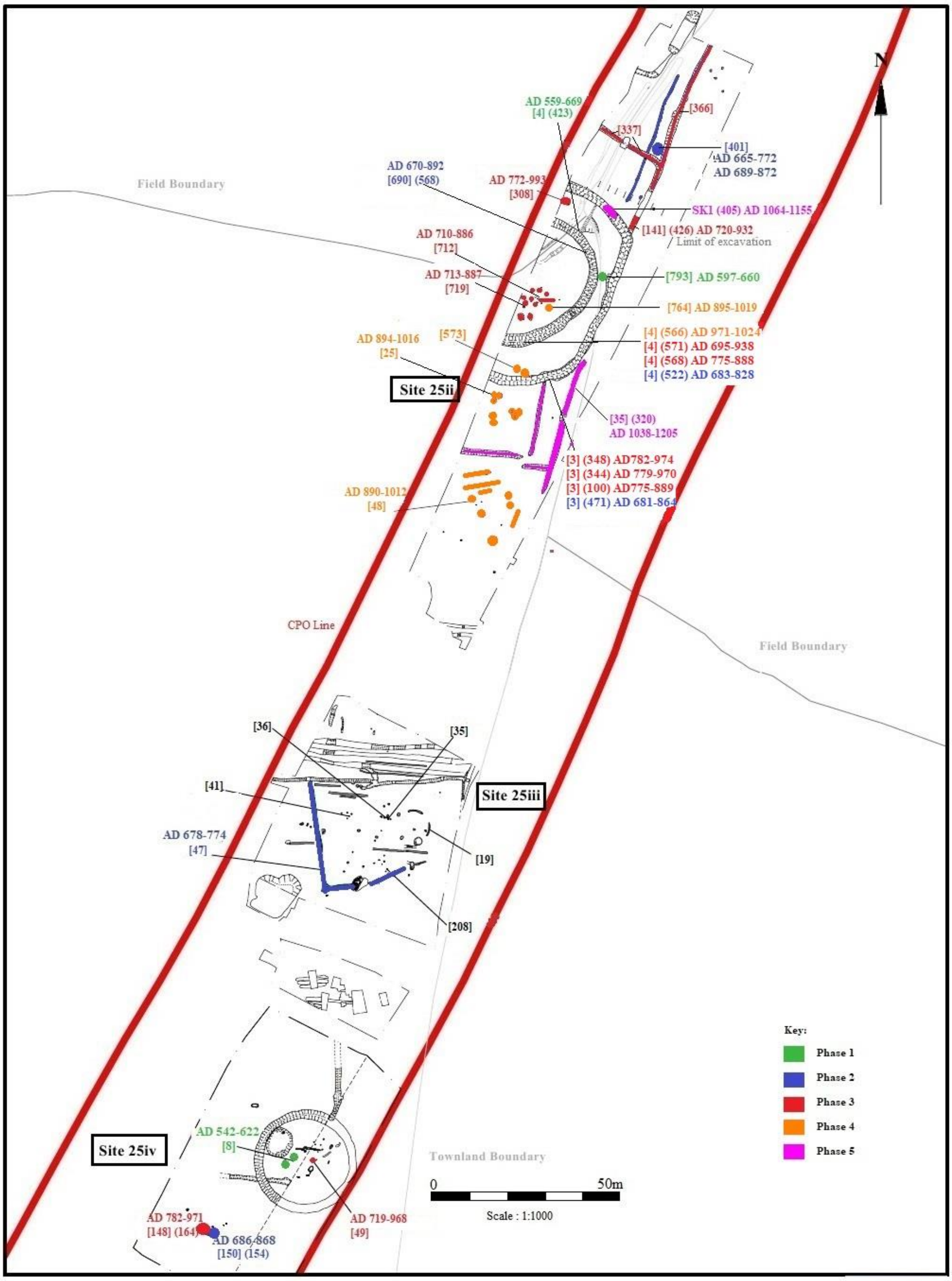


Figure 5.3.2 Ground plan of Hughes' Lot East showing main phases of activity from Sites 25ii, 25iii and 25iv

Site 25ii (03E0730) (O'Brien and Ó'Droma 2014g)

NGR: E209380 N140607 ITM: E609328.4374 N640654.0811

Extensive early medieval remains were identified on Site 25ii located to the north of the excavated area. This was a ringfort which was occupied and modified between the sixth and eleventh centuries AD. The enclosure complex comprised two concentric enclosure ditches [3] and [4], several adjacent ditches, house structures (Structure I and Structure II), cereal-drying kilns [308, 401 and 793], pits, hearths, linear ditches, gullies and skeletal remains **(Figure 5.3.3; Plate 5.3.3).** The eastern part of the ringfort complex was exposed within the road-take with the western extent situated beyond the limits of excavation.

Enclosure ditches and other ditch formations

Two major phases of the enclosure were identified. The earlier was a sub-circular ringfort [4] classified as having a uni-vallate ditch and bank. A number of radiocarbon dates from charred cereal grains, non-oak charcoal and animal bones were obtained from a slot through ditch [4], providing a good sequential date for the formation and development of the ringfort. A lowermost fill (423) dated to cal. AD 599–669 (UBA-13909); followed by deposit (552) which dated to cal. AD 683–838 (13913); deposit (571) dated to cal. AD 695–938 (UBA-13912); deposit (568) dated to cal. AD 775–888 (UBA-16215) and deposit (566) dated to cal. AD 971–1024 (UBA-16216).

Deposition of domestic and industrial refuse into the ditch [4] was occurring almost immediately after the ditch was constructed, with carbonised debris from nearby kiln [308] activity being dumped periodically into the open feature. Although no attempt was made to keep the ditch entirely free from infilled material some evidence for re-cutting was identified. The re-cut [690] was noticeably shallower than the original ditch cut and animal bone from upper fill (557) was radiocarbon dated to cal. AD 670-892 (UBA-16213). It is possible that the more sterile fills were located closer to the entrance and indicate a deliberate attempt to keep this area of the ditch "clean" of domestic refuse. Some basal fills contained a high percentage of stone and re-deposited clay and are thought to originate from collapsed material from the ringfort bank. This material is thought to have slumped into the ditch quite soon after it was constructed.

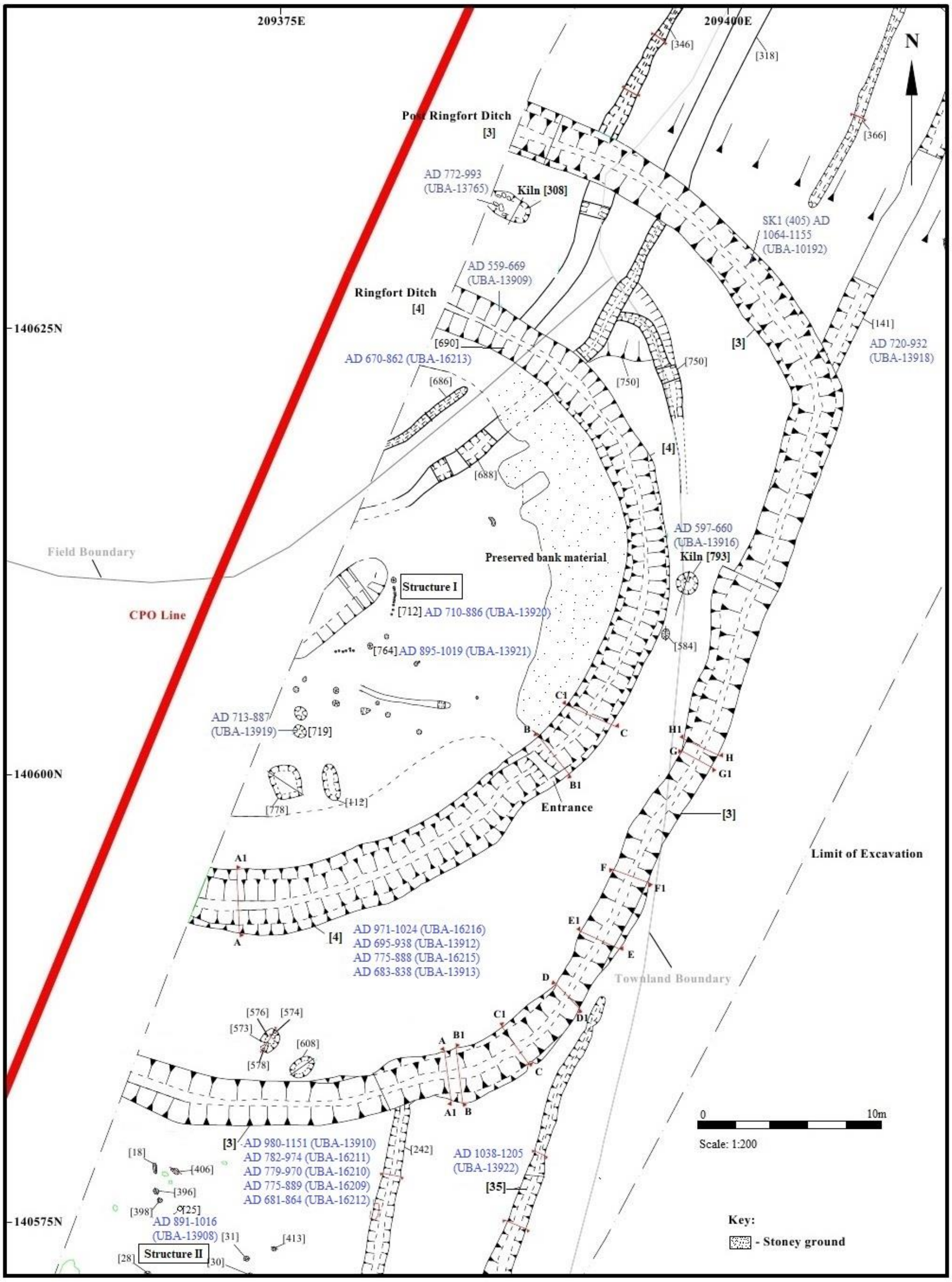


Figure 5.3.3 Ground plan of enclosures at Hughes' Lot East, Site 25ii, Co. Tipperary

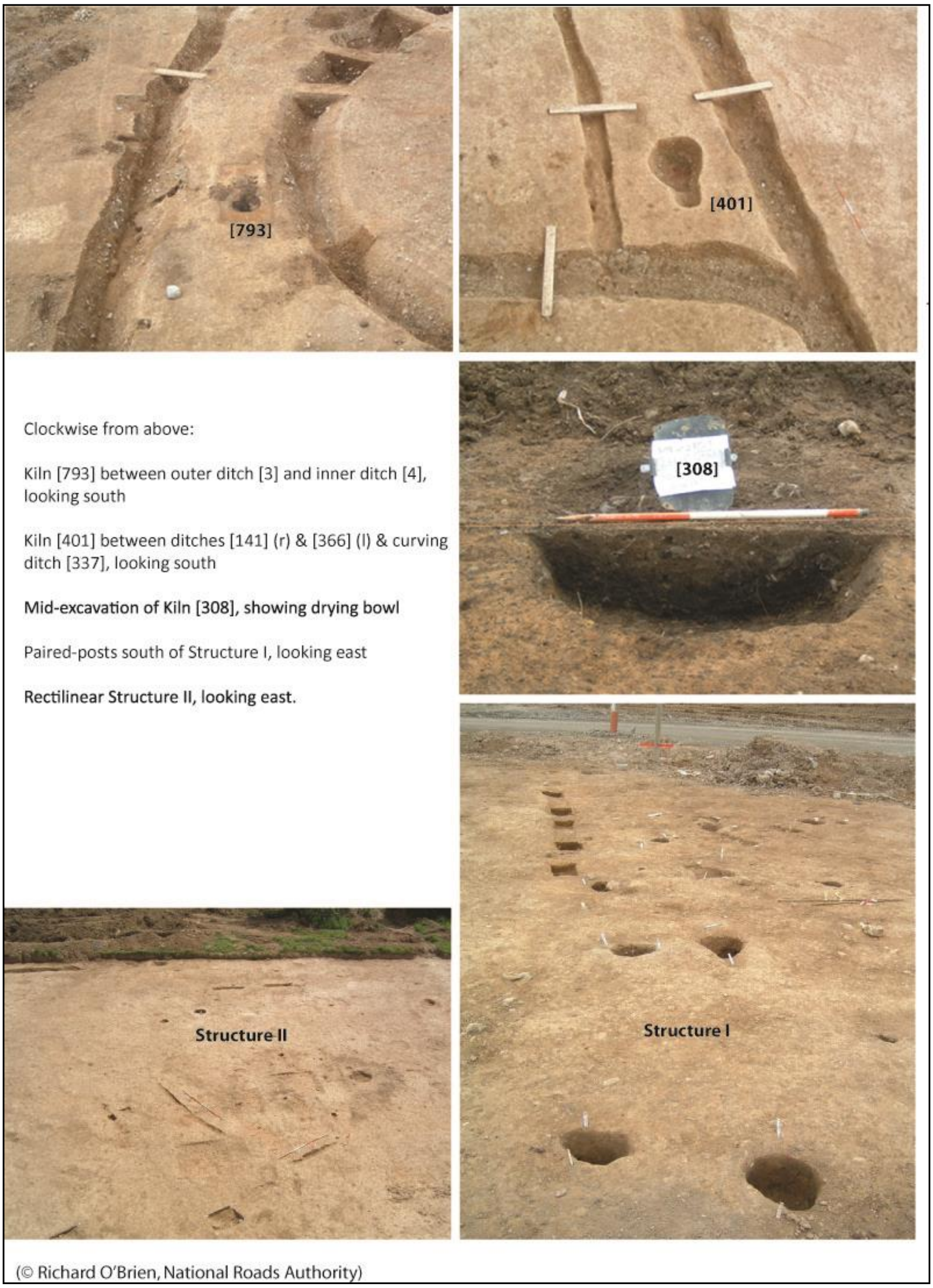


Plate 5.3.3 Corn drying kilns and Structures I and II excavated at Site 25ii

Ditch [4] continued to be occupied until it was augmented by the construction of a larger, sub-rectangular ditch [3] which entirely enclosed the earlier ditch. An upper deposit from the inner ditch [4] dated cal. AD 971–1024 (UBA-16216), proving some elements of the ditch were still being used into this later period, contemporary with the outer ditch. This deposit may be related to near the end of the period of occupation of the ringfort when the ditches had been almost entirely infilled. Dating from animal bone and charcoal remains produced a series of sequential dates for the outer ditch [3] showing that there was overlap between the use of inner ditch [4] and this later feature. Deposit (471) dated to cal. AD 681–864 (UBA-16212); deposit (344) dated to cal. AD 779–970 (UBA-16210); deposit (348) dated to cal. AD 782–974 (UBA-16211); deposit (100) dated to cal. AD 775–889 (UBA-16209) and deposit (534) dated to cal. AD 908–1151 (UBA-13910). It is possible that the earlier dates, which derive from cattle bones, originated from the earlier occupation of the ringfort, prior to the expansion represented by ditch [03]. Conversely, some or all these dates could relate to the in-filling of the outer ditch, which would make it slightly later in date than the initial ringfort ditch [04].

The ditch complex was associated with a number of nearby features including boundary ditches, such as [141], interpreted as small fields used for cultivation and animal husbandry, with a number of cereal-drying kilns exterior to the ditch. Ditch [141] was orientated south-west/north-east and extended from somewhere within outer ditch [03], along its eastern circuit, to beyond the northern limit of excavation. The ditch measured a minimum of c. 60 m long, varying from 1–2 m wide and from 0.15–0.63 m deep and yielded a date of cal. AD 720-932 (UBA-13918) from carbonised barley grain. Exterior to the outer ditch [3] a number of linears, including ditch [35] had been constructed to the north and south of the enclosure and some were interpreted as field boundaries. A radiocarbon date of cal. AD 1038–1205 (UBA-13922) from Maloideae charcoal was obtained from [35] (320).

Structures

The remains of a curving structure (Structure I) were located in the south-central area within the ringfort, defined by an arc of stakeholes on either side of a south-east facing doorway. The structure may have been sub-circular in plan, measuring c. 4.5m internally. The structure was defined by a pair of large entrance postholes, seventeen stakeholes and one posthole. The eastern interior, at the doorway, was metalled, perhaps remnants of a yard. Oak charcoal from fill (713) of stakehole [712] along the southern wall was radiocarbon dated to cal. AD 710–886 (UBA-13920). The entrance to Structure I was located at the south-east and was formed by two large doorposts [658] and [764], situated 0.8 m apart. A radiocarbon date of cal. AD

895–1019 (UBA-13921) came from the oak charcoal within doorpost [764]. A series of pits and a linear were also found to the southern and south-eastern side of Structure I. A radiocarbon date of cal. AD 713–887 (UBA-13919) derived from pit [719], making it contemporary with the date from Structure I stakehole [712].

A possible rectilinear building, Structure II was located c. 10 m outside the field ditches [39] and [477] and c. 30 m from the southern side of outer ringfort ditch [03]. The structure may have been formed by an L-shaped arrangement of five postholes, with two short linears—possible wall-slots—enclosing an area 4.5 m by 5.5 m in diameter. The longer axis was aligned east-west and enclosed two postholes, roughly centrally located. The western wall of the structure may have been defined by linear/wall-slot [48], which was dated to cal. AD 890–1012 (UBA-13761) from pomaceous wood charcoal.

Corn drying kilns

Three cereal-drying kilns [308], [401] and [793] were excavated on the site. The earliest dated early medieval feature on the site was kiln [793], cal. AD 597-660 (UBA-13916) located on the eastern side of the ringfort, lying between the inner [4] and outer ditches [3]. This date shows it to be contemporary with the primary phase of ringfort activity [4]. Two charcoal-rich pits [584] and [594], and spreads of stones possibly working-surfaces and/or bedrock outcropping were also present between both ditches. The kiln was sub-circular in plan, had sharp breaks of slope at top, concave sides down to a flat base (1.3m long x 1.2m wide x 0.12m deep). It contained three fills (796), (795) and (794); the basal fill (796) was a layer of red compact clay indicating intense oxidisation of the base.

Kiln [401] was located c. 20 m north-east of the outer ditch [3], amongst a series of inter-cutting and parallel ditches; [141], [366] and [337]. This kiln was a classic keyhole-shape in plan (2.25m long north-south x 1.50m wide x 0.75 m in maximum depth), with steep sides and a flat base. It contained three fills (402), (410) and (411); the basal fill (411) represented oxidisation of the base of the bowl. Two radiocarbon dates were obtained from this deposit; a date of cal. AD 665–772 (UBA-13763) from wild / bird cherry wood charcoal and a date of cal. AD 689–872 (UBA-13762) from hazel charcoal.

Kiln [308] was located at the western edge of excavation and lay between inner ditch [04] and outer ditch [03]. Only the drying chamber was exposed with the flue and western end of the kiln preserved *in situ.* The drying chamber was oval in plan, had steep sides down to a concave base (2m long east-west x 1.4 m wide x 0.38 m in depth) it was of similar dimensions to kiln [401]. A radiocarbon date of cal. AD 772–933 (UBA-13765) was obtained from basal fill (797). The kiln contained four fills; basal fill of the west chamber (797), basal fill of the east chamber (315), followed by (310) and upper fill (309).

Other archaeological features

A number of pits, hearths, linears and unclassified spreads and deposits were located both within and outside the enclosures [3] and [4], associated with Structure I and Structure II. Many of these features contained domestic and occupational debris such as charred cereal grain, animal bone and charcoal. There was a general absence of iron working debris or slag from the site, suggesting that metalworking activity may not have been carried out here. The only medieval dated ceramic remains identified from the site was the fragmented remains of a medieval jug, locally-made Cashel-type, wheel-thrown, glazed and typical of the mid-thirteenth to early fourteenth centuries.

Site 25iii (O’Brien and Ó’Droma 2014h)

NGR: E209355 N140457 ITM: E609303.4427 N640504.1138

Site 25iii was located approx. 50m south of Site 25ii and 50m north of Site 25iv. The only medieval activity recorded from Site 25iii was the remains of an enclosure/boundary ditch [47], which dated to cal. AD 678-774 (UBA-13774). This is likely to be an extensive of the ditch complex on Site 25ii or the remains of another ditch feature associated with activities at Site 25ii to the north and Site 25iv to the south.

Site 25iv (O'Brien and Ó'Droma 2014i)

NGR: E209317 N140363 ITM: E609265.4509 N640410.1343

Site 25iv was approx. 150m south of the medieval complex on Site 25ii. The main feature on Site 25v was a circular ringfort located close to the eastern boundary of the site and *c.* 11.5 m from the upstanding Kilscobin townland and parish boundary **(Figure 5.3.4).** The ringfort was defined by a single ditch cut into the natural. There was no trace of an associated bank although gradual erosion and later agricultural activity could account for this. No entrance to the ringfort was identified but as only 50 % of the site was excavated, the entrance may have been located along the eastern half of the site that was preserved *in situ*. The ditch, [19] measured 28 m in external diameter, 22.6 m internally, 1.8–2.5 m wide and 1.1–1.55 m deep. It contained five deposits; (5), (24), (25), (40) and (41). A series of postholes and pits were found close to the south-central portion of the ringfort, one of which, pit [49], dated to cal. AD 719-968 (UBA-13780). A radiocarbon date from birch charcoal recovered from posthole [8] (9) was dated to cal. AD 542–622 (UBA-13779).

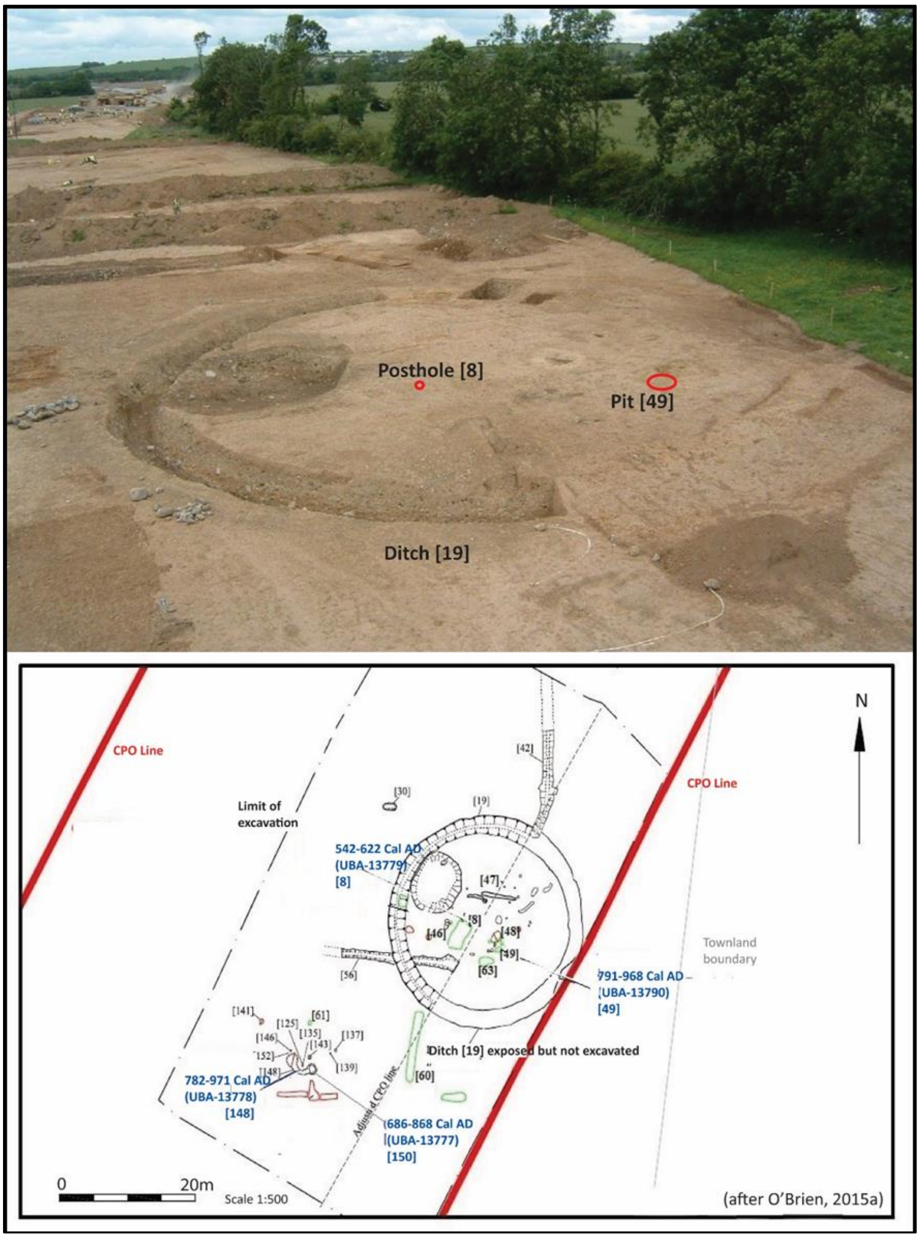


Figure 5.3.4 Top: Enclosure ditch [19] on Site 25iv, acing north-east; Bottom: Ground plan of Site 25iv

Located 20 m south-west of the ringfort were two cereal-drying kilns, one partially overlying the other **(Plate 5.3.4).** A small number of stakeholes and postholes were found around the edge of the kiln and these are discussed under Undated Features below. The two kilns differed considerably in construction technique. The lower kiln, [150] was a simple large pit but the upper, eastern kiln contained two chambers linked by a stone-lined flue lined. The lower of the two kilns [150] was aligned north-south and had a length of 4.12 m, 0.85 m wide and a depth of 1.18 m. This feature was dated to cal. AD 686-868 (UBA-13777). The second kiln [148] was aligned east-west and consisted of two circular bowl-shaped chambers, one of which was stone-lined, connected by a narrow curving stone-lined flue. The total length of the kiln was 6.17 m.

Top: Half-section of corn drying kiln [150], dated 686-868 Cal AD, facing east
Bottom: Post-excavation of corn drying kiln [148], dated 782-971 Cal AD, facing south-east

Plate 5.3.4 Corn drying kilns [148 and 150] on Hughes' Lot East, Site 25iv

The archaeological remains identified and recorded from Hughes' Lot East, revealed an early medieval settlement complex that spanned a 1km range. Based on the stratigraphical evidence and radiocarbon dating, five main phases of activity were recorded. The earliest occupation activity began to the south of the excavated area, where a smaller single ditch enclosure was constructed, which contained the remains of a structure from the late sixth to early seventh century AD. The construction of enclosure ditch [4] commenced to the north during the late seventh century as did the earliest corn drying activity [793].

Phase 2, dating from the eighth century AD was characterised by a continuation of ditch [4] and the construction of outer ditch [3], along with increased kiln activity [150 and 401] and what seems to be the construction of a rectangular ditch or boundary just 500m to the south of the main enclosure settlement. Phase 3 dated from the ninth century AD and was defined by increased occupation, with the construction of Structure I located inside ditch [4]; further kiln activity [148 and 308] and continued modifications to enclosure ditches [3] and [4]. Phase 4 saw further alterations to outer ditch [3] and the construction of Structure II between the tenth and eleventh century AD. All structural and kiln activity had ceased by Phase 5, which was defined by a series of linear ditched to the south of the enclosure; the demise of ditches [3] and [4] and an abandonment of the site by the twelfth century AD.

The main area of occupation centred on a large enclosure constructed in the seventh century AD. This ringfort appears to have been used entirely for habitation, with agriculture the main activity being practiced at the site. A smaller single ditch enclosure was also constructed at the southern extent of the excavated area, which contained the remains of a small structure and refuse pits. The presence of five corn drying kilns from the site suggests that crop processing in the form of corn drying was an important component of the site economy, while the recovery of butchered cattle bones, in addition to sheep and pig remains demonstrates that animal husbandry was also practiced. The site did not function as a cemetery-settlement site, nor did it seem to engage in any obvious craft or iron working industry. Between the seventh and eleventh century, the site was modified with the expansion of a second enclosure ditch and linear ditch sequences that seemed to define and delimit the area, possibly shifting to a more defensive function from the tenth century AD before falling out of use during the mid-twelfth century AD.

5.3.3 Bayesian modelling of Site 25 Hughes' Lot East

A total of 27 radiocarbon dates from the site as a whole (25ii, 25iii and 25iv) were used to construct a Bayesian model to help refine the chronology of medieval activity recorded at Hughes' Lot East**.** All radiocarbon dates were calibrated in OxCal 4.1, using IntCal 2009 (Reimer et al. 2009). In some cases, there was a stratigraphical relationship relating to specific features, which was taken into account in the modelling. These included the inner enclosure ditch [4] and the outer enclosure ditch [3], where vertical slots were excavated through each ditch to allow for a sequential record and date of the earliest to latest deposits. Since many of the other features dated were from single phase activities (i.e. post/stakeholes; pits and kilns), the determinations obtained cannot be placed within a clear sequence within these features nor can these features be related stratigraphically to each other.

The model constructed gave a model agreement index of 76 (A_{model} = 75.6 and $A_{overall}$ = 76) and so was deemed statistically viable for interpretation. It should be noted that one determination (UBA-16212: 1248 ±24 BP) on animal bone from the base fill (557) of enclosure ditch [3] had a slightly lower agreement index (A = 47.4%). This material is likely to be disturbed material from earlier strata and deposited within (557) when outer ditch [3] was constructed. It is retained however as it does not affect the overall agreement of the model.

To establish a clearer picture of how the site at Hughes' Lot East evolved and to understand the chronology and the relationship of features to each other, the site will be discussed in line with the modelled posteriors for the main activities recorded: inner enclosure ditch [4], outer enclosure ditch [3], structures and corn drying kilns. From this point, all modelled posterior dates are presented in italics.

Inner enclosure ditch [4]

Six determinations were used to model the start and end of the inner enclosure ditch [4] **(Table 5.3.1).** A table of the modelled posteriors at 68% and 95% probability and each index agreement is presented in **Table 5.3.2.** Three of the dates were from deposits in Slot 4 (566, 568 and 577) which provided a sequential deposition of ditch fills. Context 577 was also recorded from Slots 1, 2, 3, 4 and 8 along the ditch. One date came from Slot 1, [690] (557), a recut of [4], which was also recorded in Slots 2, 3 and 8. One date came from fill (552) in Slot 9 and one from fill (423) in Slot 10. These results provided a stratigraphic sequence for the purpose of Bayesian modelling of the ditch.

The resulting model provided an estimate for the onset of the ditch [4] construction in the range of between *630 -73AD (68.2% probability)* or *551 -775 AD (95.2% probability).* The ditch continued to be in use for some time, up until close to the final phase of activity at the site defined by outer enclosure ditch [3] and the boundary ditch [35]. The estimated latest phase of ditch [4] activity ended between *990 – 1070 AD (68.2% probability*) or *908 – 1119 AD (95.4% probability)* **(Figure 5.3.5).**

Table 5.3.1 AMS ^{14}C determinations from the inner enclosure ditch [4] on Site 25ii

Laboratory code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Context no.	Context	Material dated	Material species identification
UBA13909	1399	30	559	669	-18.6	C423	Basal fill of inner ditch [4]: Slot 4	Charred cereal grain	Hordeum sp.
UBA16213	1259	29	670	892	-20.7	C557	Ditch re-cut [690] in [4]: Slot 1	Animal bone	Not specified
UBA13913	1246	23	683	828	-26.7	C552	Fill of inner enclosure ditch [4]: Slot 4	Charcoal	Salix spp.
UBA13912	1201	32	708	938	-27.8	C571	Fill of inner enclosure ditch [4]: Slot 4	Charcoal	Alnus glutinosa
UBA16215	1187	21	775	888	-22.2	C568	Fill of inner enclosure ditch [4]: Slot 4	Animal bone	Not specified
UBA16216	1045	21	905	1024	-24.9	C566	Fill of inner enclosure ditch [4]: Slot 4	Animal bone	Not specified

Table 5.3.2 Modelled results for inner enclosure ditch [4]

Inner Enclosure Ditch [4]	Modelled dates (AD) 68.2%			Modelled dates (AD) 95.4%			Model Index	Index Agreement (A'c = 60.0%)
	from	to	%	from	to	%		
Boundary Start inner ditch C4	630	735	68.2	551	786	95.4		99.4
Phase inner ditch C4								
Sequence slot 4								
R_Date UBA13912	768	842	68.2	712	878	95.4	100.9	99.8
R_Date UBA16215	825	888	68.2	777	895	95.4	98.7	99.7
R_Date UBA16216	982	1016	68.2	900	1024	95.4	83.4	99.7
Phase slot 1								
R_Date UBA16213	698	774	68.2	678	869	95.4	94.6	99.4
After slot 10 ?residual charcoal								
R_Date UBA13909	620	660	68.2	598	670	95.4	99.5	99.7
Phase slot 2								
R_Date UBA13913	694	776	68.2	687	870	95.4	94.2	99.5
Boundary End inner ditch C4	990	1070	68.2	908	1119	95.4		99.7

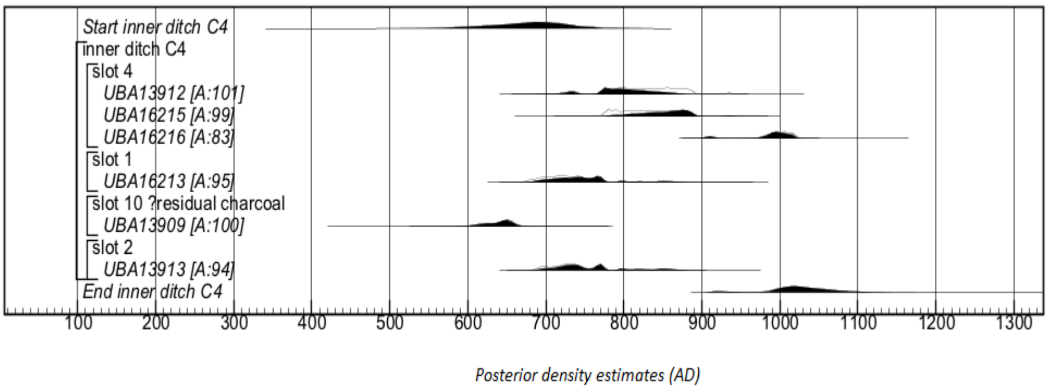


Figure 5.3.5 Probability distribution of dates associated with the inner enclosure [4]

Outer enclosure ditch [3]

Six determinations were used to model the start and end of the outer enclosure ditch [3] **(Table 5.3.3).** A table of the modelled posteriors at 68% and 95% probability and each index agreement is presented in **Table 5.3.4.** Five dates were obtained from a series of sequential deposits within the ditch; basal fills (348 and 471), middle fills (100 and 543) and upper fill (344). It is possible that the dates, which derive from cattle bones (*UBA16209* and *UBA16210*), originated from the earlier occupation of the ringfort, prior to the expansion represented by ditch [3]. One determination derived from a human burial (*UBA10192*) within a grave cut that truncated deposit (405) at the base of ditch [3]. The stratigraphical evidence suggests the grave had been cut into the silted-up basal deposit of the ditch, suggesting an internment sometime, but not immediately after, the digging of the outer ditch.

Table 5.3.3 AMS ^{14}C determinations from the outer enclosure ditch [3] on Site 25ii

Laboratory code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Context no.	Context	Material dated	Material species identification
UBA16212	1248	24	681	864	-19.5	C471	Basal fill of outer enclosure ditch [3] Slot 8	Animal bone	Not specified
UBA16209	1148	22	777	973	-22.0	C100	Basal fill of ditch [3] Slot 15	Animal bone	Cow femur
UBA16211	1145	22	782	974	-22.2	C348	Basal fill of ditch [3] Slot 4	Animal bone	Not specified
UBA16210	1134	40	779	990	-20.2	C344	Fill of outer enclosure ditch [3] Slot 4	Animal bone	Not specified
UBA13910	1011	31	908	1151	-23.9	C534	Fill of outer enclosure ditch [3] Slot 4	Charcoal	Prunus spp.
UBA10192	945	19	1064	1155	-19.7	C405	SK1 from (405) base of outer enclosure ditch [3]	Human bone	Collagen

The model has produced an estimate for the construction of ditch [3] as being between *740 – 860 AD (68.2% probability)* or *674 – 875 AD (95.4% probability).* These posteriors indicate that ditch [3] was constructed shortly after the beginning of ditch [4], which implies that the site was modified within a short period of time. Ditch [3] and ditch [4] continued to be in use/altered simultaneously for the majority of the site duration, with activity in ditch [3] ending only slightly later, sometime between *1034 – 1088 AD (68.2% probability*) or *1027 – 1150 AD (95.4% probability).* **(Figure 5.3.6)**

Table 5.3.4 Modelled results for outer enclosure ditch [3]

Outer Enclosure Ditch [3]	Modelled (BC/AD) 68.2%			Modelled (BC/AD) 95.4%			Model Index	Index Agreement (A'c = 60.0%)
	from	to	%	from	to	%		
Boundary Start outer ditch C3	740	860	68.2	674	875	95.4		99.3
Phase outer ditch C3								
Sequence slot 4								
R_Date UBA16209	780	932	68.2	777	940	95.4	84	99.8
R_Date UBA16210	887	944	68.2	834	967	95.4	119.5	99.9
R_Date UBA16211	928	966	68.2	887	980	95.4	107.8	99.8
Phase slot 8								
R_Date UBA16212 (Poor agreement A = 47.4%)	762	882	68.2	720	886	95.4	47.4	99.5
Phase slot 15								
R_Date UBA13910	994	1030	68.2	969	1051	95.4	111.7	99.8
Phase cut marked bone								
R_Date UBA10192	1025	1054	68.2	1021	1110	95.4	90.8	99.8
Boundary End outer ditch C3	1034	1088	68.2	1027	1150	95.4		99.4

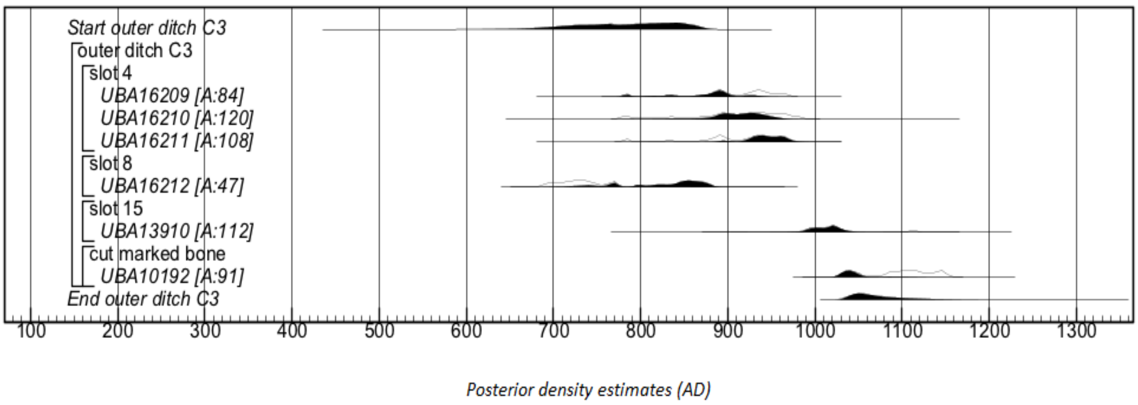


Figure 5.3.6 Probability distribution of dates associated with outer ditch [3]

Structures

Six determinations were used to model the structural activity at Hughes' Lot East **(Table 5.3.5).** A table of the modelled posteriors at 68% and 95% probability and each index agreement is presented in **Table 5.3.6** According to the posteriors generated by the model **(Figure 5.3.7)**, the earliest structure recorded at Hughes' Lot East was to the south of the site (Site 25iv), where posthole [8] generated a date of *582 – 636 AD (68% probability)* or *564 – 683 AD (95% probability) (UBA13779).* This is contemporary with the earliest construction phase of enclosure ditch [4] on

Site 25ii, which was estimated as starting between *551 – 786 AD (95% probability).* Two determinations from Structure I, located within inner ditch [4], were remodelled. A stakehole [712] *(UBA13920)* generated a posterior of *730 – 866 AD (68% probability)* or *711 – 886 AD (95% probability)*, while an ancillary pit [719] *(UBA13919)* dated to *770AD – 868AD (68% probability) or 715 – 887 AD (95% probability).*These features are clearly contemporary and place Structure I firmly within the period between the construction of ditch [4] and ditch [3].

Table 5.3.5 AMS ^{14}C determinations from structures on Hughes' Lot East

Site Name	Laboratory code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Context no.	Context	Material dated	Material species identification
25iv	UBA13779	1488	20	542	622	-24.5	C9	Charcoal rich fill of posthole [8]	Charcoal	Betula sp.
25ii	UBA13920	1219	23	710	886	-24.8	C713	Stakehole within inner ringfort ditch [712]; Structure I	Charcoal	Quercus sp.
25ii	UBA13919	1215	24	713	887	-23.8	C720	Pit [719] associated with Structure I in inner enclosure [4]	Charcoal	Quercus sp.
25ii	UBA13761	1097	27	890	1012	-28.6	C384	Fill of foundation slot trench [48] Structure II	Charcoal	Maloideae spp.
25ii	UBA13908	1083	32	894	1016	-25.4	C26	Posthole [25] south of ditch [3]	Charcoal	Taxus baccata
25ii	UBA13921	1074	27	895	1019	-27.0	C765	Doorpost of Structure I [764]	Charcoal	Quercus sp.

Table 5.3.6 Modelled results for structures from Hughes' Lot East

Structures	Modelled (AD) 68.2%			Modelled (AD) 95.4%			Model Index	Index Agreement (A'c = 60.0%)
	from	to	%	from	to	%		
Phase HLE 25ii phase A								
Phase early structure I								
After	837	...	68.2	876	...	95.4		
R_Date UBA13919	770	868	68.2	715	887	95.4	99.6	99.1
After	837	...	68.2	876	...	95.4		
R_Date UBA13920	730	866	68.2	711	886	95.4	99.5	98.8
R_Date UBA13921	904	918	68.2	895	1020	95.4	99.5	99.4
R_Date UBA13908	898	995	68.2	893	1017	95.4	99.5	99.6
First First early structure I	896	984	68.2	890	996	95.4		
Last Last early structure I	970	1015	68.2	908	1022	95.4		
Span Duration early structure I	0	59	68.2	0	101	95.4		
Phase HLE 25ii phase B								
Phase foundation wall trench struct II								
R_Date UBA13761	998	985	68.2	889	999	95.4	99.5	99.6
Phase Site HLE 25iv								
R_Date UBA13779	582	636	68.2	564	643	95.4	99.5	73.4

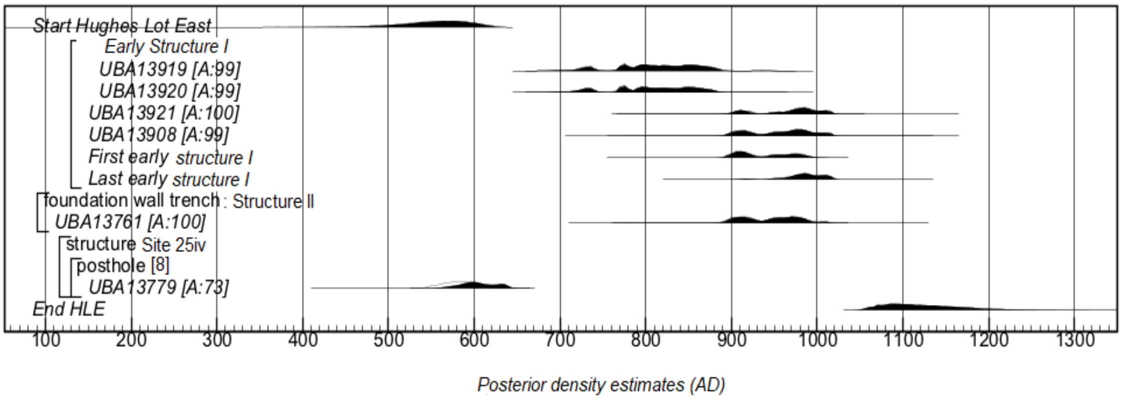


Figure 5.3.7 Probability distribution of dates associated with structures from Hughes' Lot East

A posterior for doorpost [764] *(UBA13921),* interpreted as being a later modification of Structure I, *(908 – 918 AD; 68% probability* or *895 – 1020 AD; 95% probability)* was in fact more contemporary with a posthole [25] *(UBA13908),* part of a series of structural elements located approx. 30m to the south outside the southern edge of ditch [3] and Structure II, situated approx. 20m further south.

Posthole [25] generated a posterior of *898 – 922 AD (68% probability)* or *893 – 1017AD (95% probability)*, while slot trench [48] *(UBA13761)*, associated with Structure II was estimated to date to *898 – 985 AD (68% probability)* or *889 – 999 AD (95% probability)*. This suggests that Structure II was built at the same time the larger enclosure ditch [3] was evolving, with an expansion of building occurring at this time towards the inside of the enclosure [3], at the same time inner ditch [4] was going out of use. The span difference in time between the end of Structure I and the beginning of Structure II has been estimated at 100 years *(95% probability)*, which also provides a plausible timeframe for the expansion of both enclosure ditches **(Figure 5.3.8).**

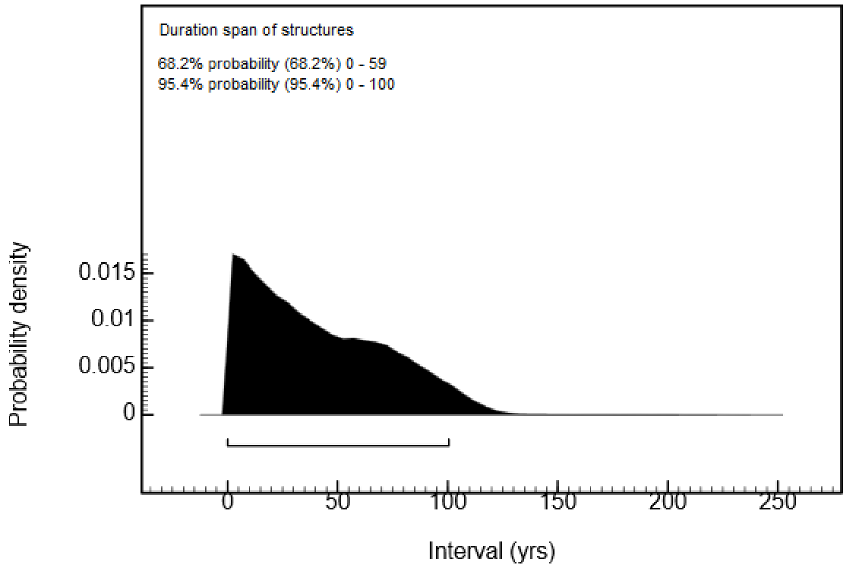


Figure 5.3.8 Duration span of structures (I and II) on Site 25ii

Corn drying kilns

Seven determinations were used in the model to generate posteriors for the corn drying kiln activity recorded at Hughes' Lot East **(Table 5.3.7).** Three kilns were identified from Site 25ii [308, 401 and 793], while two kilns were situated approx. 150m further south on Site 25iv [148 and 150]. In addition, a pit feature [49] located close to kilns [148 and 150] was interpreted as a rubbish pit for kiln debris. A table of the modelled posteriors at 68% and 95% probability and each index agreement is presented in **Table 5.3.8.**

Table 5.3.7 AMS ^{14}C determinations from corn drying kilns on Hughes' Lot East

Site Name	Laboratory code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Context no.	Context	Material dated	Material species identification
25ii	UBA13916	1416	25	597	660	-26.0	C795	Basal fill of crop drying kiln [793]	Charcoal	Fraxinus excelsior
25ii	UBA13763	1295	22	665	772	-28.5	C402	Basal fill of crop drying kiln [401]	Charcoal	Prunus sp.
25iv	UBA13777	1241	23	686	868	-26.1	C154	Fill of corn drying kiln [150]	Charred cereal grain	Hordeum sp.
25ii	UBA13762	1236	22	689	872	-23.0	C402	Basal fill of crop drying kiln [401]	Charcoal	Corylus avellana
25ii	UBA13765	1192	24	772	993	-27.9	C797	Fill of crop drying kiln [308]	Charcoal	Fraxinus excelsior
25iv	UBA13780	1182	37	719	968	-25.2	C46	Charcoal clay fill of pit [49]	Charred cereal grain	Avena sp.
25iv	UBA13774	1148	20	782	971	-28.1	C164	Fill of corn drying kiln [148]	Charcoal	Alnus glutinosa

According to the model kiln [793] situated just outside enclosure ditch [4] to the west Site *(UBA13916)* generated a posterior of *618 – 661 AD (68% probability)* or *597 – 660 AD (95% probability)* in line with the earliest construction date for ditch [4] and the structure further south on Site 25iv. A second kiln phase seems to have occurred defined by kiln [150] *(UBA13777)* on Site 25iv and kiln [401] *(UBA13763)* located further north of enclosures [3 and 4].

Table 5.3.8 Modelled results for corn drying kilns

Corn drying kilns/associated features	Unmodelled (AD) 68%			Modelled (AD) 95%			Model Index	Index Agreement (A'c = 60.0%)
	from	to	%	from	to	%		
Phase HLE 25ii								
Phase kilns								
Phase kiln 308								
R_Date UBA13765	780	875	68.2	768	894	95.4	99.9	99.9
Sequence kiln 401								
R_Date UBA13763	670	758	68.2	664	767	95.4	99	99
R_Date UBA13762	715	863	68.2	697	876	95.4	94.2	94.2
Phase kiln 793								
R_Date UBA13916	618	651	68.2	597	660	95.4	100.8	100.8
Span Duration kilns	170	249	68.2	128	280	95.4		
First First kilns HLE 25ii	618	651	68.2	597	660	95.4		
Last Last kilns HLE 25ii	812	882	68.2	771	892	95.4		
Phase Site HLE 25iv								
Sequence kiln								
R_Date UBA13777	686	870	68.2	683	860	95.5	106	106
R_Date UBA13778	777	970	68.2	775	953	95.4	78	78
First First kiln HLE 25iv	694	776	68.2	683	860	95.5		
Last Last kiln HLE 25iv	776	940	68.2	775	953	95.4		
Phase pit 49								
R_Date UBA13780	772	866	68.2	710	946	95.4	99.7	99.7

The posteriors for both kilns show them to be somewhat contemporary, with [150] dating to *694 – 776 AD (68% probability)* or *682 – 860 AD (95% probability)* and [401] dating to *670 – 758 AD (68%probability)* or *664AD – 767AD (95% probability).* Kiln [401] seems to have been had a second phase of use, which was dated to *715 – 863 AD (68% probability)* or *697 – 876 AD (95% probability),* suggesting this feature was in use over a considerable length of time.

A third kiln phase also existed at the site, represented by kiln [148], possibly superseding kiln [150] on Site 25iv, and kiln [308], located between inner ditch [4] and outer ditch [3] at the northern extent of [3] on Site 25ii. Kiln [148] *(UBA13778)* produced a posterior date of *776 – 940 AD (68% probability)* or *774 – 953 AD (95% probability)* and is contemporary with a nearby rubbish pit [49] *(UBA13780),* dating to *772 – 866 AD (68% probability)* or *710 – 946 AD (95% probability).* Further north kiln [308] generated a posterior of *780 – 875 AD (68% probability)* or *768 –*

894 AD (95% probability). There is also a possible overlap with the later phase from kiln [401] in this case **(Figure 5.3.9).**

To summarise, the model estimated that the first phase of kiln activity [793] at Hughes' Lot East dated to *597– 660 AD (68% probability)* or *618 – 651 AD (95% probability).* The next kiln phase defined by kilns [150/401] was estimated as occurring between *694 – 776 AD (68% probability)* or *682 – 860 AD (95% probability),* while the final kiln phase [148/308] is likely to have dated to *771 – 892 AD (68% probability)* or *774 – 953 AD (95% probability).* The model also projected that the kiln activity is likely to have occurred over a period of between *170 – 249 years (68% probability)* or *128 – 280 years (95% probability)* **(Figure 5.3.10).**

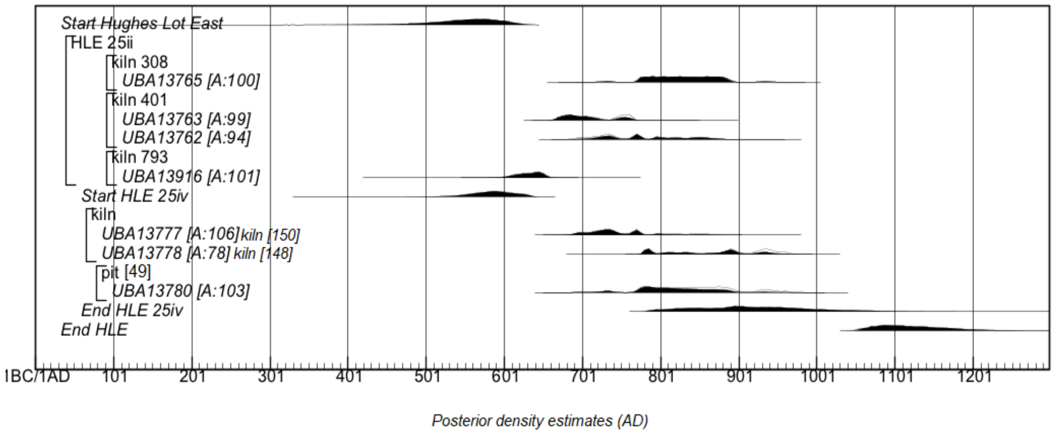


Figure 5.3.9 Probability distribution of dates from corn drying kilns and associated features

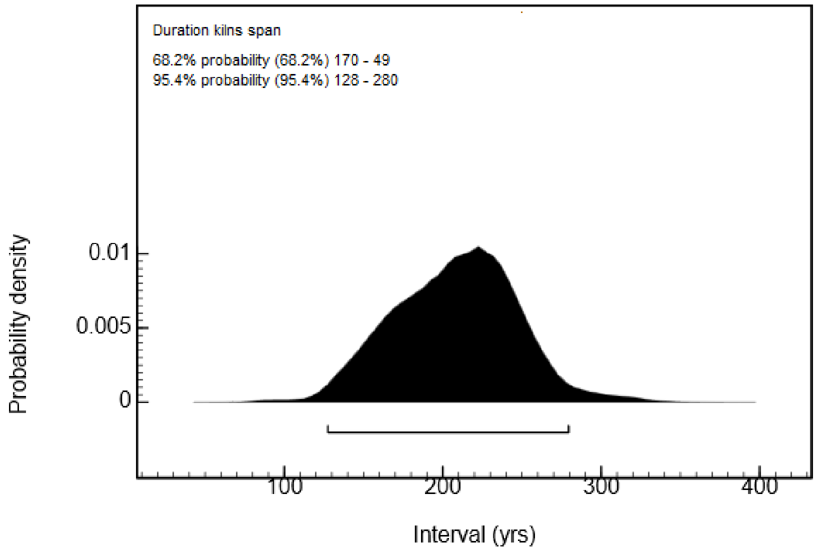


Figure 5.3.10 Probability of duration span of corn drying kiln activity at Hughes' Lot East

Overview of chronological activity at Hughes' Lot East

By combining the posteriors for the main phases of activity at Hughes' Lot East, the Bayesian model has estimated that the earliest activity at the site may have occurred between the ranges of *519 – 604 AD (68% probability)* or *443 – 628 AD (95% probability)* **(Figure 5.3.11).**

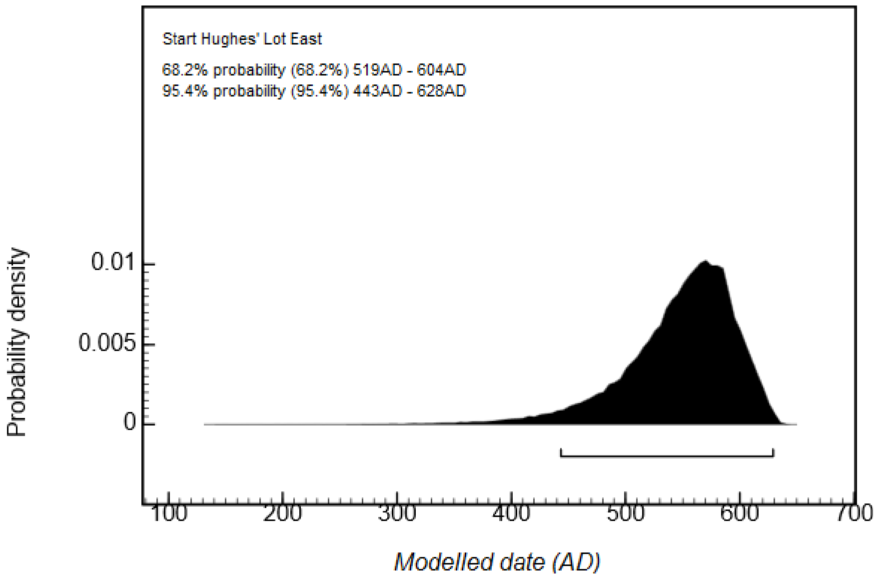


Figure 5.3.11 Modelled start date for activity at Hughes' Lot East

This modelled sequence of events **(Figure 5.3.12)** implies that the earliest phase of medieval activity is likely to have commenced in the south on Site 25iv, where the remains of a structure within a small enclosure [19] was identified and dated to *564 – 643 AD (95% probability)*. When this date was merged and modelled with all dates for the site, a posterior estimate of *518 – 639 AD (68% probability)* or *559 – 619 AD (95% probability)* was postulated for the earliest activity in this southern section. While the exact function of the structure mentioned is unclear, the high volume of fragmented animal bone retrieved from the excavated features in and around the structure and enclosing ditch suggests some form of working area.

Activity then navigated north with the first phase of corn drying kiln activity [793] and the construction of enclosure ditch [4], estimated as beginning between *630 – 735 AD (68% probability)* or *551– 786 AD (95% probability)* to form the main settlement complex. This seems to expand with modifications to enclosure ditch [4], the beginning of constructing enclosure ditch [3] and a second phase of corn drying kilns [401] to the north and further south [150], which has been estimated as dating to *682 – 860 AD (95% probability).*

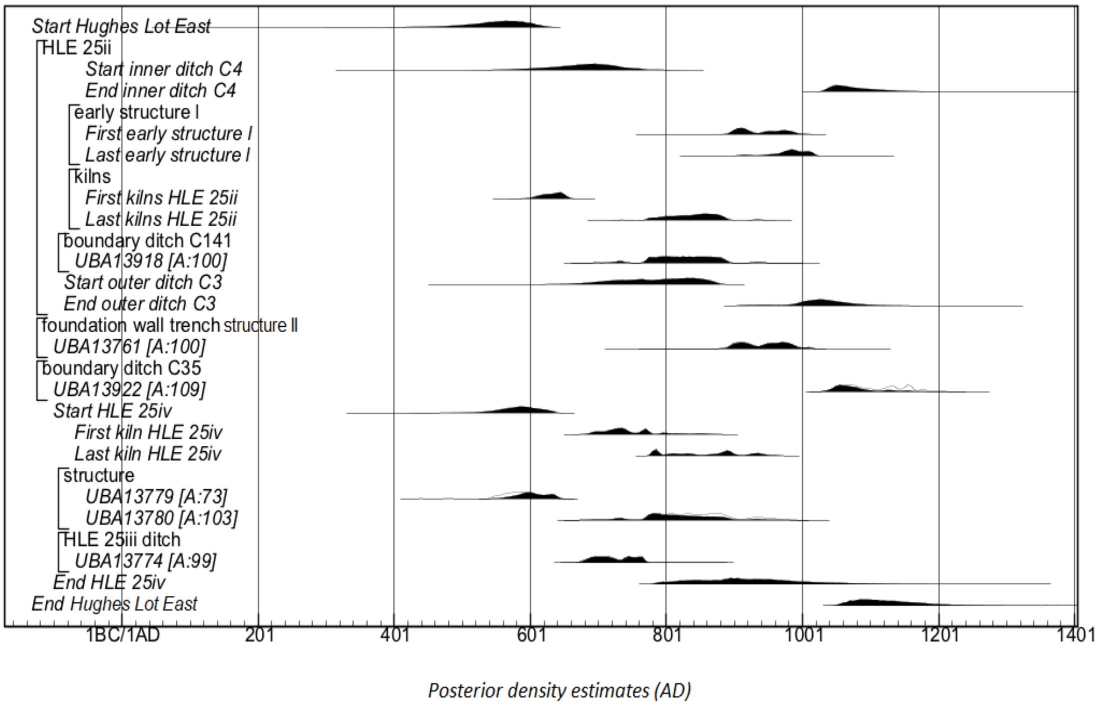


Figure 5.3.12 Probability distribution of dates from the main phases of activity at Hughes' Lot East

The construction of Structure I inside ditch [4] soon followed *(715 – 887 AD; 95% probability)* along with a series of linear ditches to the north [e.g.141] *(721 – 937 AD; 95% probability),* which may have functioned as a dumping ground for the nearby kiln activity [308 and 401]. This occupation phase at the site runs concurrently with the third phase of kiln use [308 and 148] which has been estimated as dating to *774 – 953 AD (95% probability).* With the expansion and adjustments to the larger enclosure ditch [3], Structure II was estimated to have been constructed south of the ditch to *889 – 999 AD (95% probability).*

No further evidence for corn drying kilns were recorded at the site at this time, suggesting a shift in settlement/economy type or how the site was functioning. It has been postulated through the archaeological evidence that the site became more defensive in nature with the expansion of a more formidable enclosure [3] and surrounding boundary ditches. It is also probable that the site came to an abrupt end as a result of increased social instability, marked by skeletal remains showing evidence for weapon trauma, which was deposited in the base of ditch [3] dating to *1021 – 1110 AD (95% probability) (UBA10192).* This may be why ditch [4] went out of use c. *908 – 1119 AD (95% probability)* followed by outer ditch [3] sometime c. *1027 – 1150 AD (95% probability*).

Posterior density estimates from the model suggests that activity at Hughes' Lot East came to an end sometime between *1060AD – 1151AD (68% probability)* or *1047AD – 1236AD (95% probability)* **(Figure 5.3.13).** Interestingly, taking the individual posteriors for the site, activity at Hughes' Lot East is likely to have ceased occupation prior to the first wave of Anglo-Norman accounts for Cashel in the 1170's (Davis White 1892, 12) and did not form part of the new social and cultural biography that was to take hold during the 13th century as evident by moated sites on neighbouring Boscabell and Windmill Hill and the tower house at Gortmakellis.

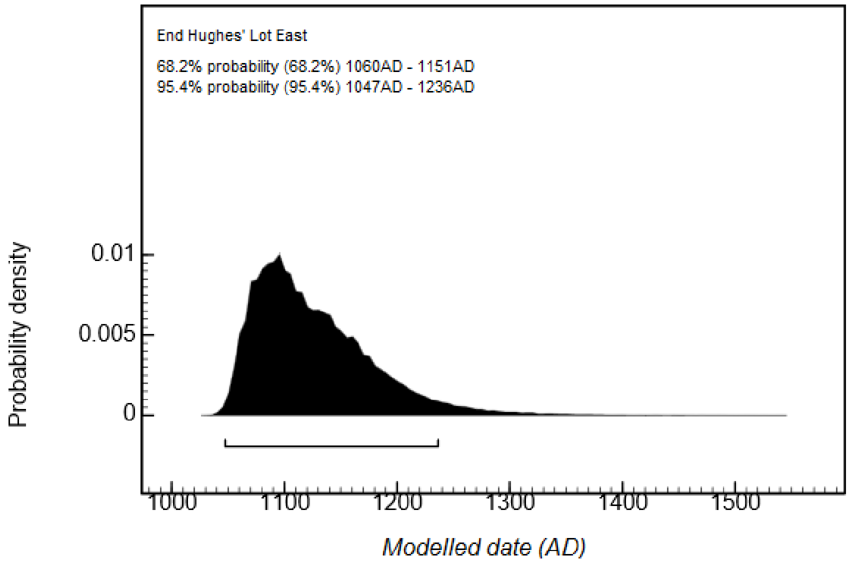


Figure 5.3.13 Modelled end date for activity at Hughes' Lot East

5.3.4 Charcoal results from Hughes' Lot East

Fourteen wood taxa totalling 3,063 charcoal identifications were recorded from the charcoal samples associated with Hughes' Lot East. The assemblage was dominated by *Quercus* sp. accounting for 32% of the assemblage followed by *Corylus avellana* at 25%. *Fraxinus excelsior* made up 15%, with pomaceous woods (Maloideae spp.) and *Salix* sp. accounting for 11% and 8% respectively. Much lesser occurrences of *Prunus* sp. (3%), *Prunus avium/padus* (2%), *Prunus spinosa* (1%), *Betula* sp. (1%) and *Alnus glutinosa* (1%) were present. *Ilex aquifolium*, *Euonymus europaeus*, *Taxus baccata* and *Ulmus* sp. accounted for <1% of the overall assemblage **(Figure 5.3.14).**

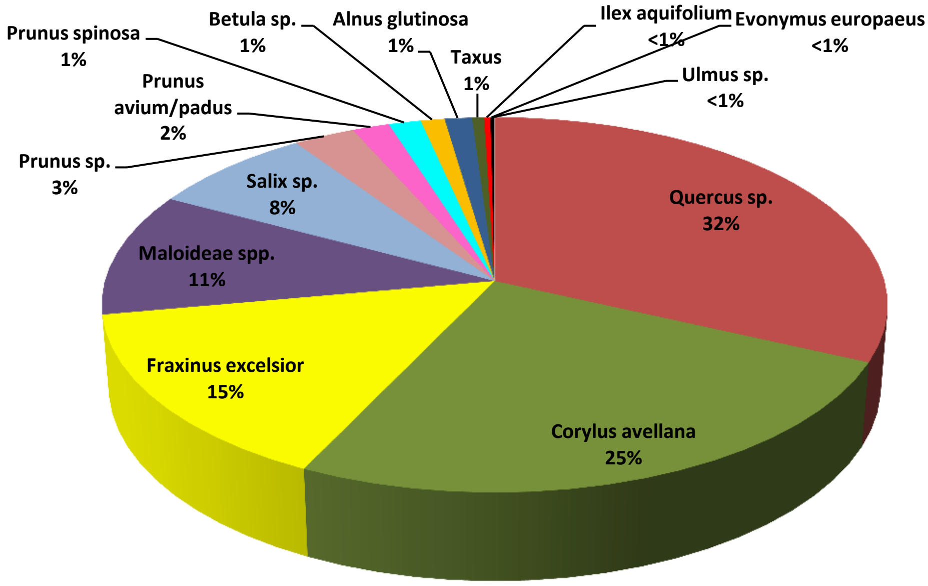


Figure 5.3.14 Percentage of wood taxa from Hughes' Lot East (n = 3,063)

The charcoal analysis from the early medieval enclosure complex at Hughes' Lot East, is demonstrating at local level the variety of wood taxa being used at this site from the seventh to the eleventh century AD. The record of activity represents a continuity and expansion of the settlement, characterised by episodes of building, domestic works and phases of arable farming in the form of corn drying. The distribution of wood taxa from the various features is showing a distinct use of hazel, ash and oak for building works, pits and hearths, in contrast to oak, hazel and Maloideae and *Prunus* woods found in corn drying kilns. The enclosure and boundary ditches defining the extant and specific working areas within the site shows similar taxa, with a higher incidence for ash, Maloideae and willow **(Figures 5.3.15-18)**

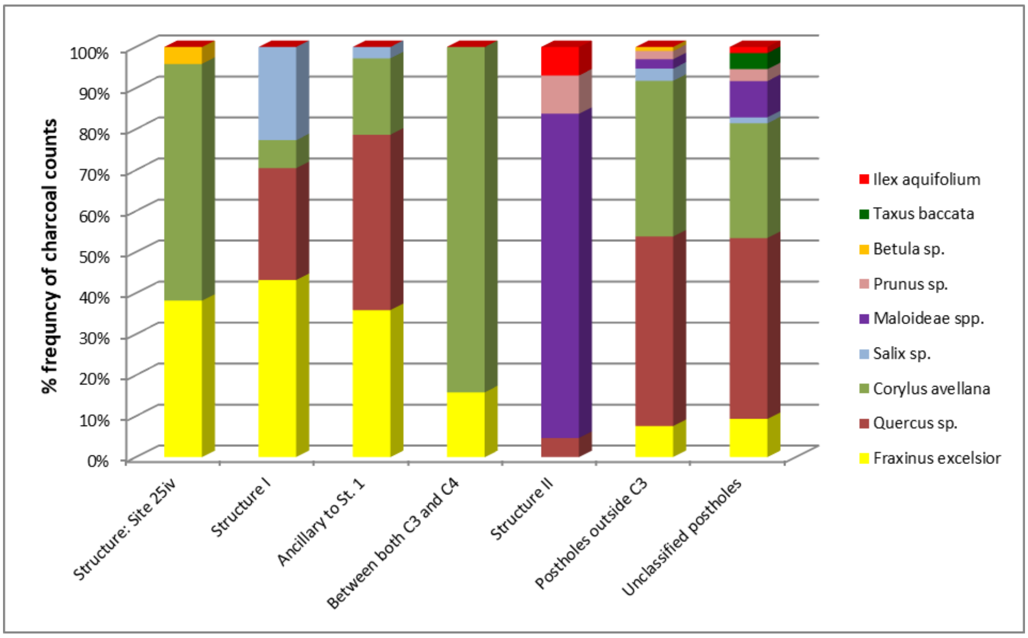


Figure 5.3.15 Distribution of wood taxa from structural features (n = 855)

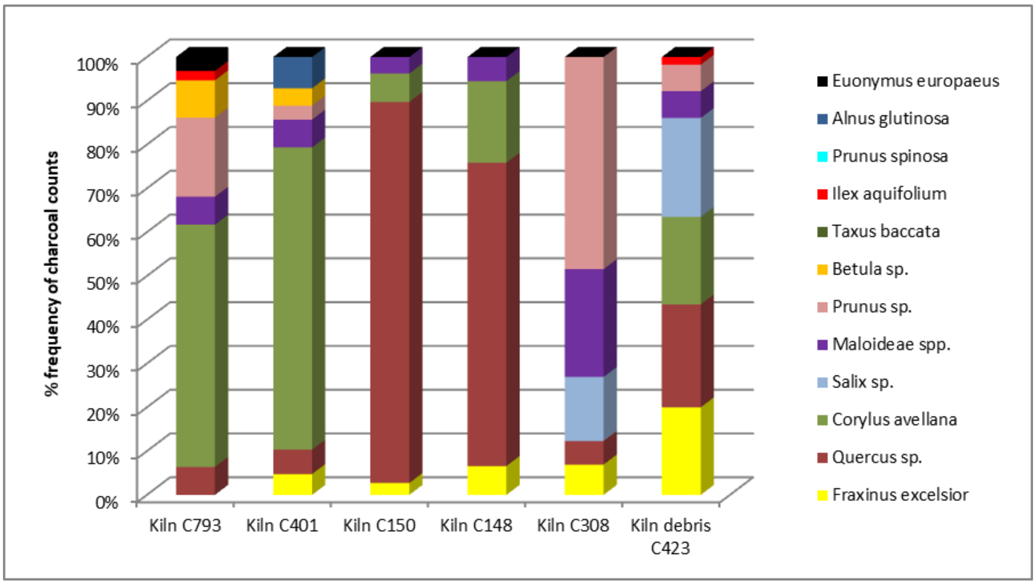


Figure 5.3.16 Distribution of wood taxa from corn drying kilns (n = 741)

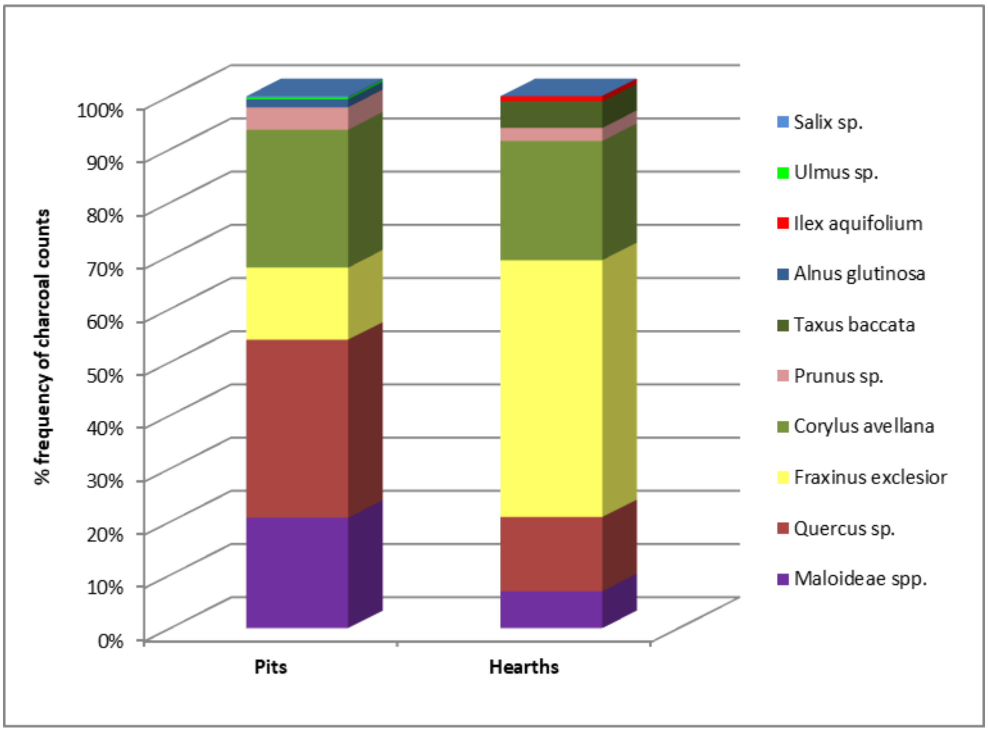


Figure 5.3.17 Distribution of wood taxa from pits and heaths (n = 533)

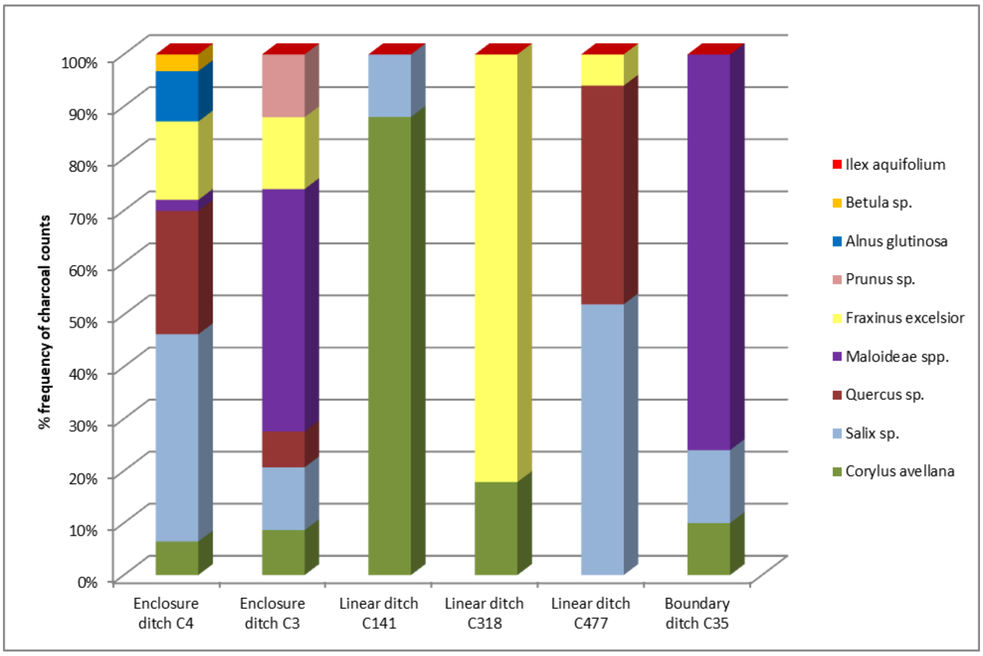


Figure 5.3.18 Distribution of wood taxa from enclosure/linear/boundary ditch features (n = 329)

Chronological changes to wood taxa from Hughes' Lot East

With the chronology of activity at Hughes' Lot East now refined through Bayesian in-depth modelling, the wood taxa from the features defining these phases can now be interpreted **(Figure 5.3.19).** The earliest phase at the site (Phase 1) is defined by ash and hazel in the earliest structure [19] dating to *559 – 619 AD (95% probability)* located to the south and pre-dating the construction of the large enclosure ditch [4]. The evidence for oak and a more mixed wood assemblage is more pronounced with the development of the site enclosure complex *551– 786 AD (95% probability)* defined by ditch [4] and corn drying kiln [793], at which point there is a rise also in the fruitwood species (Maloideae spp. and *Prunus* sp.).

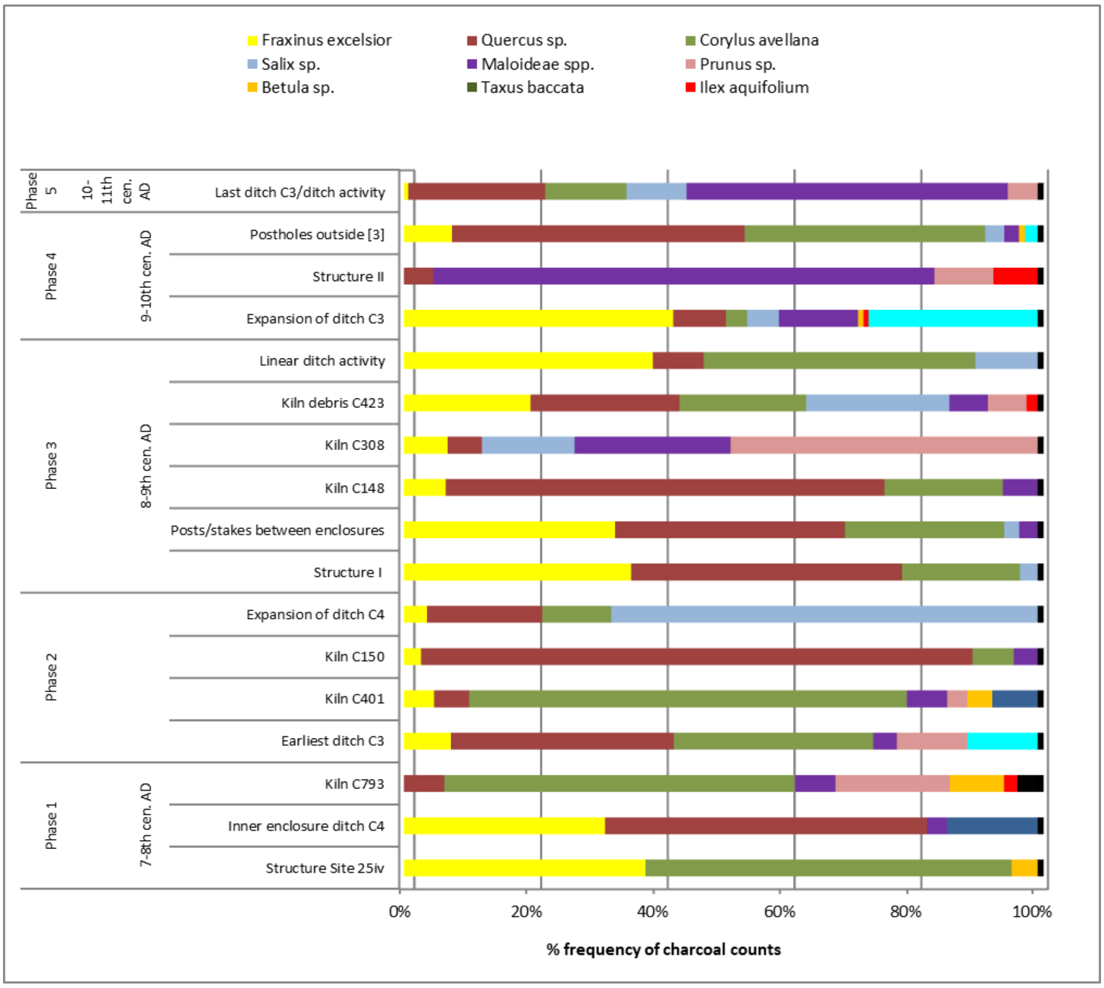


Figure 5.3.19 Distribution of wood taxa by phase at Hughes' Lot East (n = 3,036)

During the next phase of activity (Phase 2) ash use declines slightly with the development of the outer enclosure ditch [3], a pattern also evident in the contemporary kilns [150 and 401] and the expansion of inner enclosure ditch [4], at the same time oak values increase, which is dated to *682 – 860 AD (95% probability).* Hazel is more prominent in kilns [793 and 401] during this time possibly reflecting that its use on the site is increasing as the settlement expands. This follows the macro trend noted from the overall results for this medieval period, where a diverse wood taxa emerges, interspersed with periods of high and low ash or oak use. Ash values increase again soon thereafter (Phase 3) with the construction of Structure I and ancillary structures located within inner enclosure [4] *(715 – 887 AD; 95% probability)*, indicating that ash was now an important resource for structural activity, together with oak and hazel, all woods proven to be indicative of early medieval house building.

While all three taxa are present in contemporary kilns [148 and 308], ash is lower, while oak values are higher in [148] and lower in [308]. Could this trend reflect the relative availability of oak on site during different phases of activity at this time? Kiln [148] is in use during a period when oak supply on site is higher, while kiln [308] reflects a phase of lower oak resource use. In contrast, ash values rise in the linear ditch activity and as ditch [3] evolves (Phase 4), oak is low once again. This phase is also defined by Structure II, which dates to *889 – 999 AD (95% probability).* By this time, ash values have decreased considerably and do not form part of the fabric of Structure II, which contains oak and a notable high level of Maloideae species. Similarly oak and hazel are found predominantly in external post and stakeholes located outside ditch [3], interpreted as later undefined structural activity. While present, ash is again much lower in line with the pattern of higher oak use.

By the time the site goes out of use (Phase 5) which dates to *1027 – 1150 AD (95% probability*), the ash signal is gone, while oak remains. This pattern then indicates that ash use at the site is declining from c. *889 – 999 AD*, a trend that is noted from the broader charcoal picture and which fits with the proposed Bayesian model as discussed in Section 4.4.3. To draw attention to other wood taxa being used at the site, the rise in fruitwood species is a feature of the charcoal record from the seventh century, rising steadily during the eighth and tenth century phases of site activity. This is also being identified more broadly during periods of variable oak and ash use, where wood diversity increases on sites dating from the sixth century AD.

Considering the charcoal record for context-related variation, the results displayed through ordination shows that features characterised by structure [19], ditch [4], kilns [793, 401 and 150] and Structure 1 in Phase 1-3 have proportionally more abundance of ash and hazel. Alder, willow and *Prunus* species feature more prominently in contexts associated with the expansion of ditch [3] and kilns [150 and 308], while oak and Maloideae woods are more abundant from Phase 4 and later, with the construction and activity related to Structure II and the latter use of the site **(Figure 5.3.20).**

The use of alder and willow is interesting in the context of ditch activity at Hughes' Lot East. Both taxa are found more frequently in ditch deposits of enclosure ditches [3 and 4] and a series of linear and boundary ditches that define specific working areas but generally under-represented in structural and kiln features. This is also the trend being expressed in the broader set of results **(Section 4.3.4)** and fits with the overall picture emerging from medieval settlements, that alder and willow found in ditches are possibly representing their use in fencing or palisade construction rather than being remnants of fire debris, deposited into these features with other domestic refuse. It also offers some insights into the nature of ditch features which required the use of water-tolerant taxa.

Open ditches may have been prevalent to waterlogging through natural means or as a result of poor drainage. If these features were overcut or disturbed the sub-surface water table, they may have contained standing water. Analysis of the insect remains from Roestown and Killickaweeny, Co. Meath revealed that ditches were left open and contained standing stagnant water (Reilly 2003a, Reilly 2009) which helps to support the use of alder and willow in these contexts.

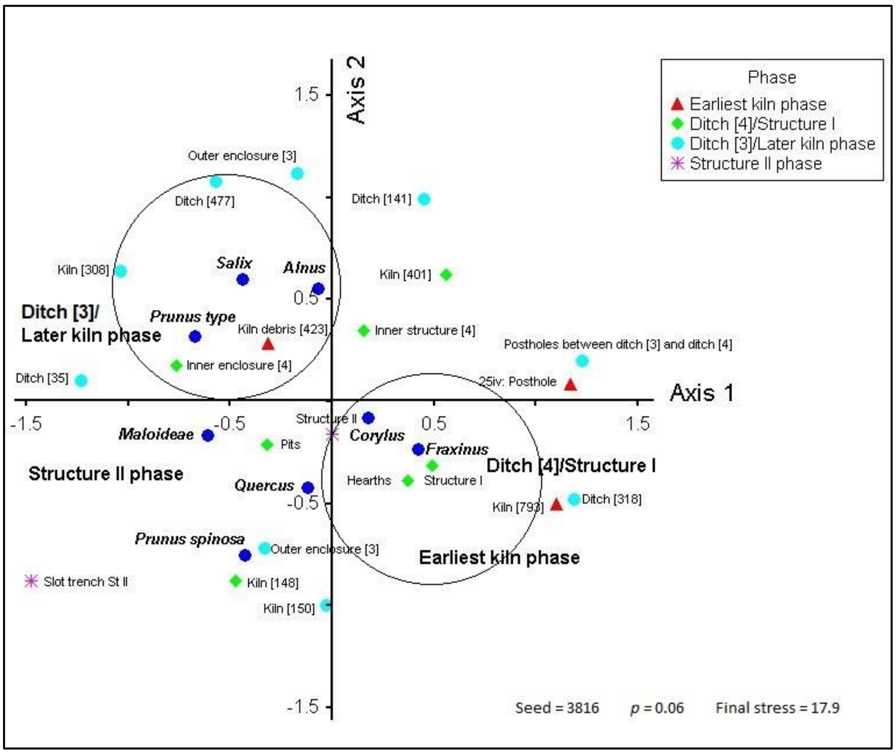


Figure 5.3.20 NMS Axis 1v2 ordination of combined samples from Hughes' Lot East Site 25 (No. of samples: 121; No. of counts: 2,486)

Table 5.3.9 Correlations (Pearson's *r*-value) of explanatory variables for Hughes' Lot East (values in red are statistically significant at p<0.05 level for two-tailed t-test)

Taxon	**Axis 1** *r-value*	**Axis 2** *r-value*
Fraxinus excelsior	**-0.439**	-0.307
Salix sp.	-0.395	0.656
Prunus spinosa	**-0.402**	**-0.465**
Corylus avellana	0.209	-0.124
Prunus sp.	**0.345**	0.198
Quercus sp.	**0.12**	**-0.517**
Alnus glutinosa	0.034	0.337
Maloideae spp.	**0.575**	-0.2

In **Table 5.3.9** above attention is drawn to the poor correlation on both axes between oak and other taxa, indicating it may not be used in the same way or at the same time as when other woods were. The Maloideae woods have a stronger positive correlation with the *Prunus* wood group in Axis 1, while ash, willow and blackthorn are at similar negative values. This suggests that the fruitwood species are found together more, but not in the same way as ash/willow/blackthorn. The hazel correlation value is moderate on both axes and could imply its general use at the site for a range of activities.

This output of results could help with interpreting the general functional nature of wood resources at the site and when they were used. It seems where typical woods deemed more suitable for construction are being used (i.e. oak and ash) they are notably correlated with blackthorn. As presented in Chapter 1, blackthorn is referenced in early law tracts as the wood of choice in fencing during the early medieval period, particularly for structures to keep animals penned in or out of certain areas (Kelly 1997, 375). Similarly, oak is also documented as being used in fence construction for heavier fencing associated with demarking woodland for example (ibid.). It is highly plausible then that this arrangement could denote a period of fence construction at the site. The correlation shows a strong association between ash with blackthorn (Axis 1) and oak with blackthorn (Axis 2), but poor correlation between ash and oak (Axis 1). This supports the hypothesis that oak and ash have an inverted relationship, rarely occurring in high frequencies together at the same time. During periods when oak is unavailable or prioritised in another way, ash is used in its place, as demonstrated through its variable occurrence with blackthorn at Hughes' Lot East.

A significant pattern of the corn drying kiln activity from Hughes' Lot East is the rise in fruitwood species when oak and ash are much lower and vice versa. This corresponds to the broader results of charcoal from kilns **(see Sections 4.3.4** and **5.5),** which is revealing that oak, ash and in some cases hazel are poorly correlated to fruitwood species in this context. Periods of oak, ash and hazel use (i.e building and construction) therefore differ to when fruitwood species are either brought to or used at the site.

5.3.5 Overview of wood use at Hughes' Lot East

The distribution of wood taxa from the early medieval settlement at Hughes' Lot East provides a profile of wood resource use through the charcoal record for context-related variation and changes in wood dynamics at the site over time. While it is difficult to fully extrapolate the wood used explicitly at the site, the trends being observed do mirror the broader picture of wood resource use being reflected. A more mixed variety of woods intermingled with how and when oak and ash are being used is a major facet of the charcoal results, a trend that seems to be at play from the sixth century AD to the late ninth/early tenth century, at which time ash use declines, while oak remains constant and in some cases dominates the supply. During this time, periods of ash and oak fluctuate supporting the claim that oak is not always available and is substituted or supplemented by ash at certain times. This is also a period when the fruitwood species appear in frequent use and continue to be a feature of the record well into the 10th century and later.

Willow and alder seem to have found their place in the archaeological charcoal record and their presence in ditches offers new insights into the nature of structures that existed in these features particularly if they retained water and the selection of woods for fencing versus house building for example. The most significant results however are those from the corn drying kilns. This case study has helped to support the theory that these features are symptomatic of changes in activity at a site, particularly periods of building works and managing or maintaining fruitwoods trees and that the occurrence of these activities may have been mutually exclusive reflecting seasonal duties associated with when corn drying kilns were in use. This will be further explored in **Chapter 5 (Section 5.5).**

Oak v Ash

Another feature of the charcoal results from this study is the relative use of oak and ash, which seems to display an opposing frequency in many features or phases of activity dating from the sixth to ninth century AD **(Figure 5.3.21).** At Hughes' Lot East, ash values are high during the seventh century AD but decline in favour of oak, which rises in use towards the beginning of the eighth century AD after which it declines significantly.

During the eighth and ninth century phase of occupation, ash and oak values are more sporadic across the site, with variable periods of high ash and high oak recorded. This signals that ash is now being used more at the site, possibly as a response to a decrease in oak availability or accessibility, as oak values are seen to dip from the previous phase. At the onset of the ninth/tenth century, ash use at the site begins to wane as oak sees a discernible increase, returning to similar frequencies recorded from the seventh/eighth century phase.

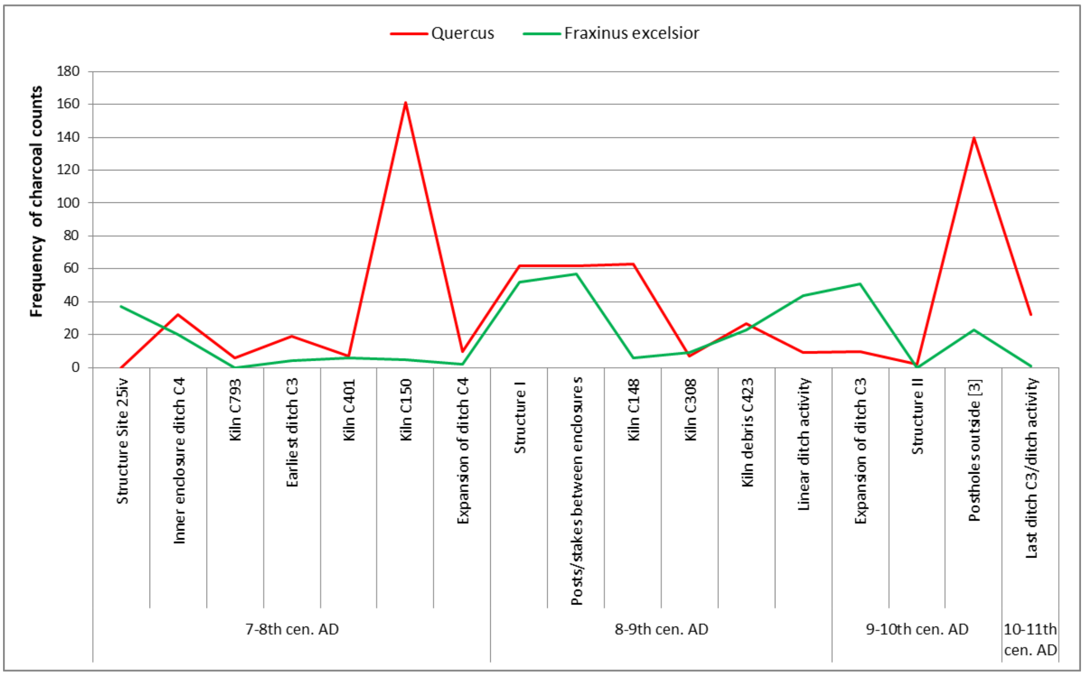


Figure 5.3.21 Comparison between frequency of oak and ash from Hughes' Lot East (n = 989)

While local availability and site resource use will impact on how and when these taxa are being used directly and indirectly across the site, it is apparent from this case study that there are fluctuating periods of frequent oak and ash usage. Of particular interest is the period towards the end of the seventh century, when oak values decline and enters into an irregular pattern of use between the eighth and ninth century at the same time ash values are increasing. Based on the weight of results discussed in Chapter 4 **(Section 4.3),** this trend could signal when oak availability was at its most vulnerable at this site. This may be a response perhaps to settlement/population pressure, the prioritising of certain domestic or specialised activities, socio-political change effecting resource management or a diminishing supply as a result of the contracting wooded landscape. This will be further explored in Chapter 6 where other strands of archaeological evidence in line with the historical record will help to explain the oak conundrum of the eighth and ninth century AD.

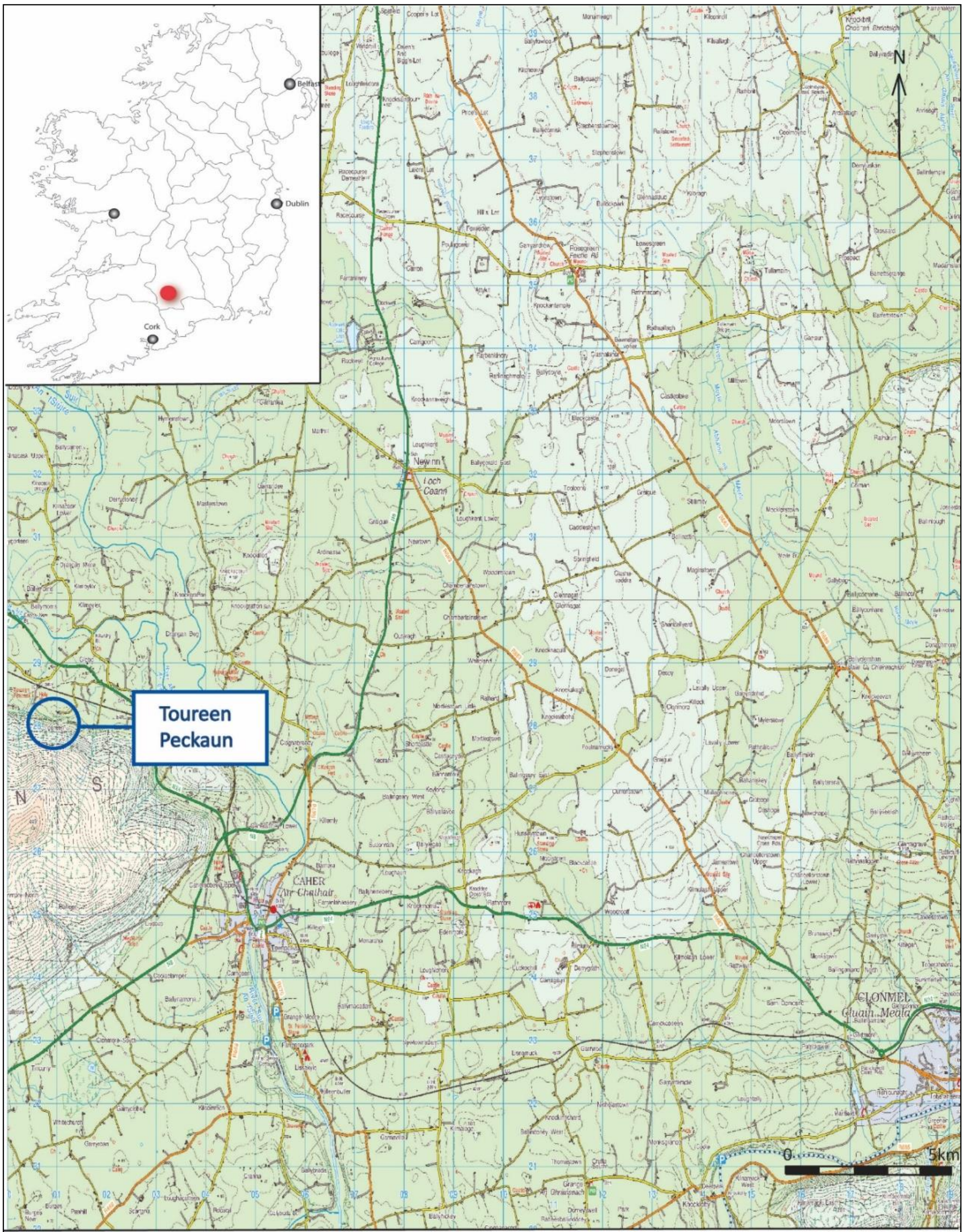
5.4 Toureen Peckaun, Co. Tipperary (05E0247) (Ó'Carragáin 2008)

NGR: E201245 N128163 ITM: E600463 N628561

5.4.1 Introduction

Toureen Pecaun is located in the parish of Killardry and the barony of Clanwilliam at the east end of the Glen of Aherlow in the northern foothills of the Galtee Mountains, less than 10km northwest of Cahir, in the south of county Tipperary **(Figure 5.4.1).** This site is the location for the monastery of *Cluain Aird Mo-Becóc*, occasionally mentioned in the early annals and martyrologies and named after St Beccán, who died in AD 689/90 (Annals of Inishfallen). The site also attracted a group of Viking raiders in AD 833. Peakaun's stream runs roughly N-S, east of the centre of the site. A number of monuments recorded at the site comprise a series of crosses, cross-slabs, inscribed slabs, bullaun stones, a sundial and a holy well (TS075-023002-076).

Most of these are situated in a small field just west of the Pecaun stream, but the full extent of the site is indicated by a substantial earthen enclosure (200m in diameter) (TS075-023007), which was identified by Conleth Manning (1991). A small Romanesque church (TS075-023001) is also located within this ecclesiastical enclosure. The church was taken into State care in 1935, reconstructed in 1944 by the Office of Public Works and partially excavated by Duignan as part of these works (Waddell and Holland 1990; Manning 1991). Window fragments, a sun-dial (TS075092376-) and many cross-inscribed slabs (TS075-023010- to TS075-023044) were uncovered and inserted into the fabric of the church.



Location of Toureen Peckaun, Co. Tipperary
Ordnance Survey of Ireland Discovery Map Series no. 74
© OSI & Government of Ireland
Scale 1:100000@A3

Figure 5.4.1 Location of Toureen Peckaun, Co. Tipperary

5.4.2 Archaeological background

Archaeological excavations at Toureen Peckaun were undertaken by Dr Tomás O’Carragáin of University College Cork between 2005 and 2008 to investigate the development and extant of the ecclesiastical enclosure and settlement therein. The main areas targeted were identified by a geophysical survey (2005) and a DTM (2006/7) of the site. In 2005 and 2006 two trenches were excavated in the northern field, Trenches A and B, and two in the eastern field, Trenches C and D. In 2007 Trench D was reopened and extended and a new trench, Trench F, was opened and fully excavated within the area occupied by the Romanesque church. In 2008 three trenches were opened; Trench D was reopened and completed in 2008; Trench G was opened to investigate the palaeochannel immediately south of Trench D (Channel 3) in order to determine the extent to which this has been artificially modified and to ascertain if a mill-race existed and Trench E was opened and completely excavated to the north of the palaeochannel on the northern border of Trench D (Channel 2) **(Figure 5.4.2).**

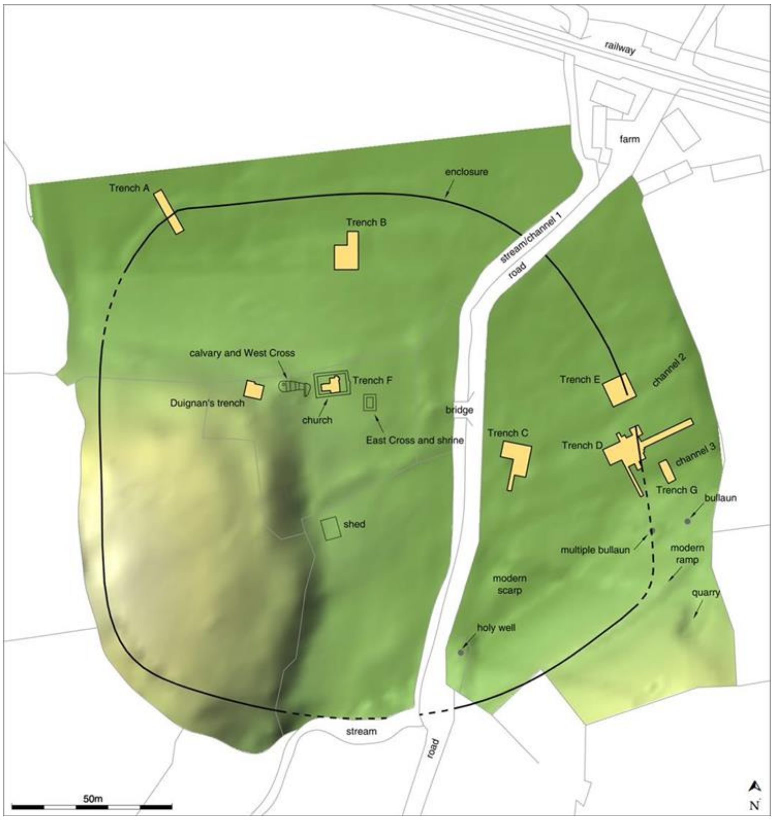


Figure 5.4.2 Ground plan of trench locations at Toureen Peckaun (O’Carragáin 2008)

The excavations revealed a number of phases characterising the development of the site from the earliest enclosure dating to the late seventh century AD to the construction of the twelfth century Romanesque church and later burial activity. The first early medieval activity (Phase 1) was concerned with demarcating the site as a whole. It comprised a continuation of the boundary ditch, as identified by Manning (1991), in Trench A and Trench E [690] and the remains of an enclosing palisade [767], represented by a number of postholes identified in Trench D **(Figure 5.4.3).** No occupational evidence was identified in Trench A, possibly due to the lowlying waterlogged nature of the site in this area (O'Carragáin 2008). Two radiocarbon dates were obtained from the palisade in Trench D, posthole [160] was dated to 658-769 Cal. AD (UBA-7101) and posthole [767] located at the south terminal dated to 420-584 Cal. AD (UBA-16285). The latter date is tenuous as it came from oak charcoal, so could be the product of 'old wood' effect.

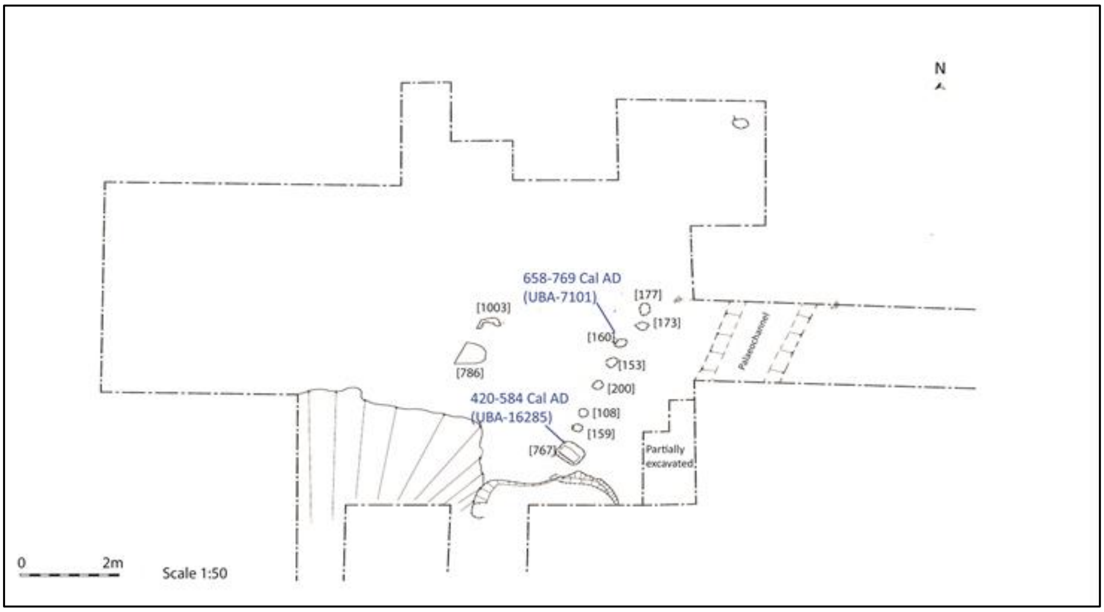


Figure 5.4.3 Ground plan of Trench D, Phase 1, showing line of palisade (after O'Carragáin 2008)

Phase 2 marked a shift to apportioning the interior of the enclosure for the purpose of occupation and habitation, particularly noted in Trench D **(Figure 5.4.4).** In Trench E, initial settling of the bank material occurred and the sides of the ditch [690] were stabilised. Subsequently, a thick fill of peat (654/860) developed within the ditch indicating a stationary, waterlogged environment.

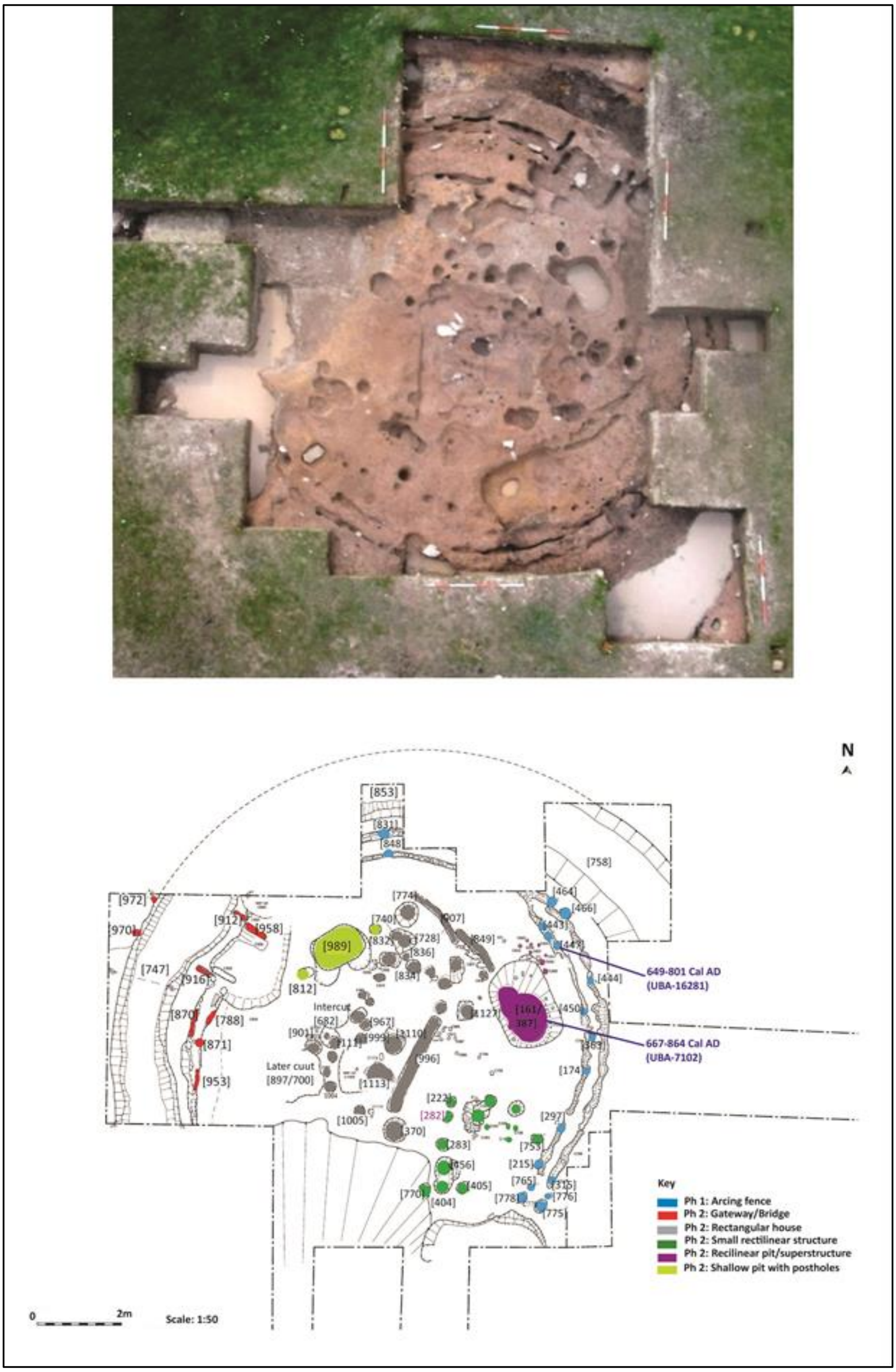


Figure 5.4.4 Top: Aerial view of Trench D showing Phase 1 (outer palisade structure) and Phase 2 (central habitation activity); Bottom: Ground plan of Trench D (after O'Carragáin 2008)

A number of brushwood and worked wood elements were recovered from deposit (654) and a hazelnut shell from the latter was radiocarbon dated to 724-888 Cal. AD (UBA-16296). In Trench D, an enclosing ditch [747, 758, 883] was identified, inside of which was a pair of carefully constructed parallel curvilinear plank and post fences enclosing an area 8.8m in diameter, with an overall diameter of c.13.6m E-W. It presumably removed several postholes of Phase 1 palisade and must have joined with the small water channel to the southeast. Ash charcoal from a stakehole [447] at the east side of the fence was radiocarbon dated to 649-801 Cal. AD (UBA-16281), while a rectilinear pit [161/387] was dated to 667-864 Cal. AD (UBA-7102). During this phase access to the enclosure was via a bridge and gate at the northwest of the main trench. Immediately to the west of the bridge there was a break in the parallel fences for a gate represented by another pair of parallel slots 0.6m long [928] and [958] and 1.1m apart.

At the centre of this enclosure a rectangular N-S oriented building was constructed (4.4m x 1,4m internally). Some of the postholes cut one another, suggesting it was repaired or rebuilt on at least one occasion. The west wall was represented by up to 15 postholes and the north wall by two slot trenches. The east wall had five postholes and a 2.45m long slot with a number of stake and possibly plank holes in its base. Only 4 small postholes were excavated along the south wall of the building, but it is possible that a southwest corner-post was removed by Phase 3 cuts [700] and [897]. The interior of the building was heavily truncated by Phase 3 pits. A possible internal partition was evident near the north end (836), (1116), (833), (834), (961), but it seems more likely that this is the original N wall of the building and that it was later extended north. A smaller square (2.2m E-W x 1.8m N-S internally) building probably rested against the parallel fences at the SE. A number of postholes were recorded along the north, west and south walls. Due to later cultivation disturbance no internal features indicating its possible function survived, except possibly for a few stakeholes in its northeast quadrant.

A large sub-rectangular pit [161/387] just northeast of the main building may also belong to this phase, as may a group of stakeholes just northeast of it. This pit originally had a light super-structure over it, as evidenced by a substantial central post and six stakeholes positioned on its sides. Its original function is uncertain.

After the superstructure had been removed, it may have functioned as a cess pit and later still, during Phase 3, it was filled with industrial waste. Another large subrectangular pit [989], just northeast of the building may also be contemporary with it. There was a posthole at either end of it and it possibly functioned as a shallow well.

At some point the Phase 2 fences and buildings fell out of use and were dismantled and the area was reused for industrial purposes (Phase 2/3). No evidence for buildings in Trench D was identified during this phase. Instead a series of pits was dug in the area previously occupied by the main rectilinear building [723], [932], [1009], [768], [948] and [448] **(Figure 5.4.5).** Most of the deposits were rich in charcoal and included some burnt bone (no unburnt bone survives on the site), burnt clay and some also contained slag. This area was covered by clay-rich layers (209), (252), (211/246) and a radiocarbon date from (209) yielded a date of 672-867 Cal. AD (UBA-16280). These layers excavated in Trench D seem to have built up incrementally during Phase 3 to seal disused pits and to act as surfaces into which other pits could be dug. The remains of possible corn drying kilns were also identified [682], [700], [768] and [843] however there was little evidence for *in situ* burning and the primary deposits (hearths, flue linings etc) were removed from the latter before they were filled with industrial waste. Two relatively shallow pits [463] and [897] did produce evidence for *in situ* burning and hammerscale was identified in their primary fills, possibly representing smithing hearths.

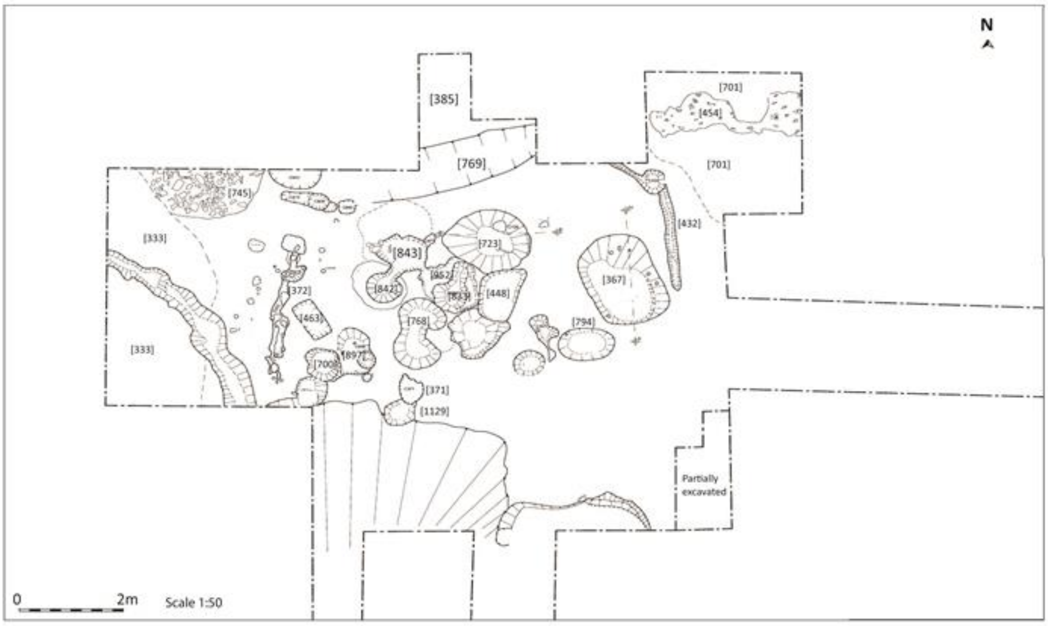


Figure 5.4.5 Ground plan of Trench D, Phase 3 (industrial activity) (after O'Carragáin 2008)

In Trench C, pits containing iron working [75] and [224] were cut into the upper fill (129) of a large linear feature [231]. These were probably backfilled over a short period after the foundation of the monastery as a radiocarbon date of 668-865 Cal. AD (UBA-7103) was somewhat contemporary with pit [75], which dated to 660-769 Cal AD (UBA-7104) and pit [224] dating to 672-867 Cal. AD (UBA-7105). This activity was also contemporary with the date for deposit (209) in Trench D mentioned above, signalling the end of Phase 2/beginning of Phase 3.

In Trench E (Phase 4) a levee was laid down in order to stem the flow from the stream into the ditch on the western side of the bank, which overflowed into the interior of the site **(Figure 5.4.6).** At the southwest of the trench (inside the bank) a sequence of levee deposits (626), (805) and (806) formed a barrier. Two deposits (807) and (808) to the north of the levee were identified as collapse from the levee and it is therefore likely that the levee was breached on two occasions and repaired after each instance. Phase 4 in Trench D was defined by the uppermost Phase 3 features, which were disturbed by the roots of one or more trees or bushes (221/226/229/313, 227/235/222) and by a series of E-W cultivation potentially dating to the post-medieval period.

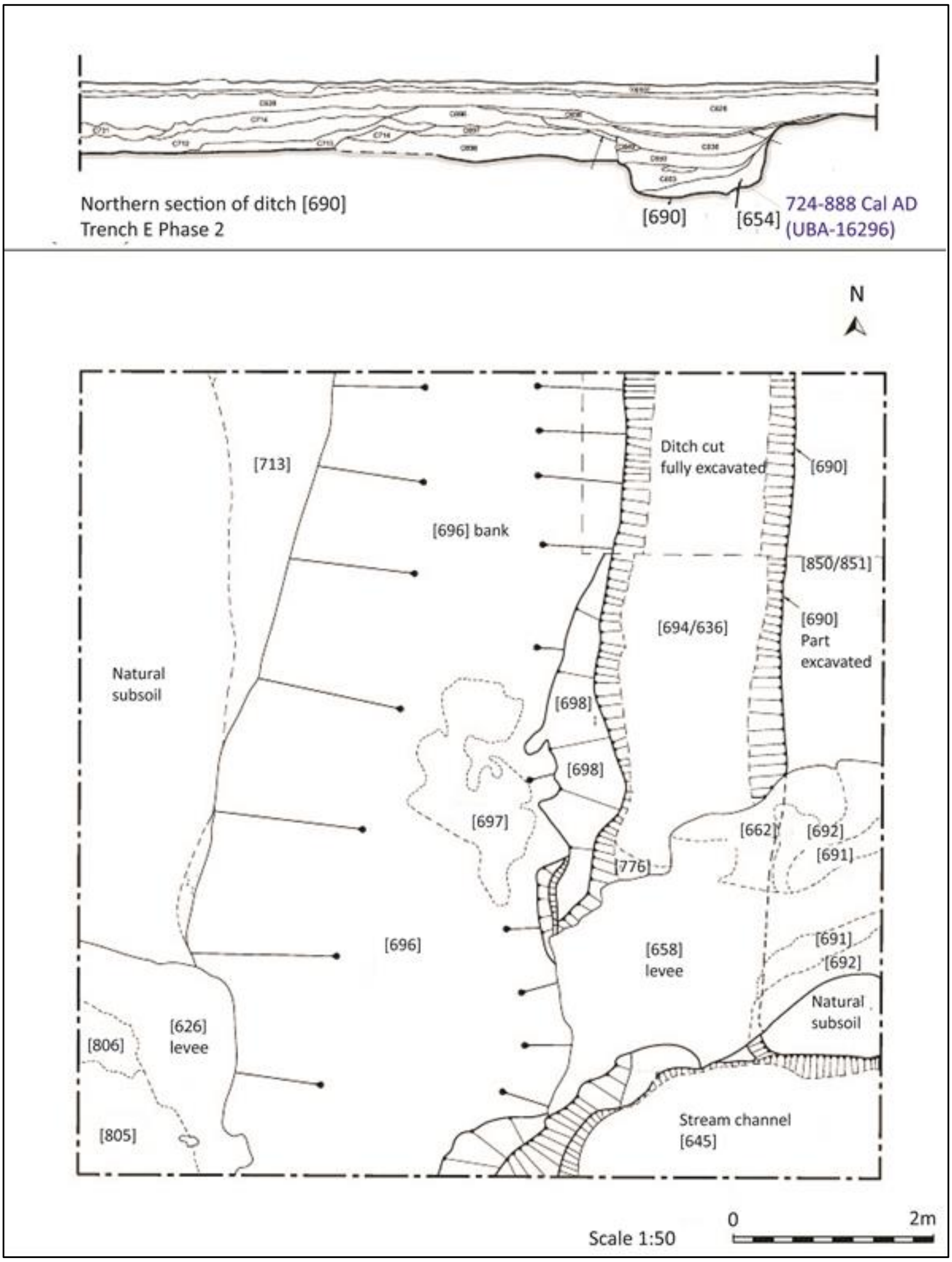


Figure 5.4.6 Ground plan and section of enclosure ditch [690] in Trench E (after O'Carragáin 2008)

Trench F provided an opportunity to excavate the interior of the Romanesque church. Some evidence for earlier structures, probably churches, was found, though not enough to reconstruct any plans for them. A large pit [522] from this level produced a radiocarbon date of 669-809 Cal. AD (UBA-16279), contemporary with the later dated activity for Phase 3. Two postholes [528] and [508] associated with a possible earlier church structure were identified and dated to 779-966 Cal. AD (UBA-16284) and 894-1030 Cal. AD (UBA-16283) respectively. A group of eight pre-twelfth-century burials was excavated, one of which contained a broken early medieval inscribed stone. Two radiocarbon dates from two of the graves (421) and (519) were dated to 888-1030 Cal. AD (UBA-16292) and 895-1017 Cal. AD (UBA-16295). A larger group of burials post-dating the construction of the Romanesque church were also excavated, the radiocarbon dating of which revealed three additional burial phases – Contexts (368) and (494) dated to 1223-1289 Cal AD. (UBA-16287) and 1278-1390 Cal. AD (UBA-16291); Context (417) was dated to 1310-1413 Cal. AD (UBA-16290) and Contexts (384) and (490) dated to 1413-1630 (UBA-16289) and 1435-1630 (UBA-16288) **(Figure 5.4.7).**

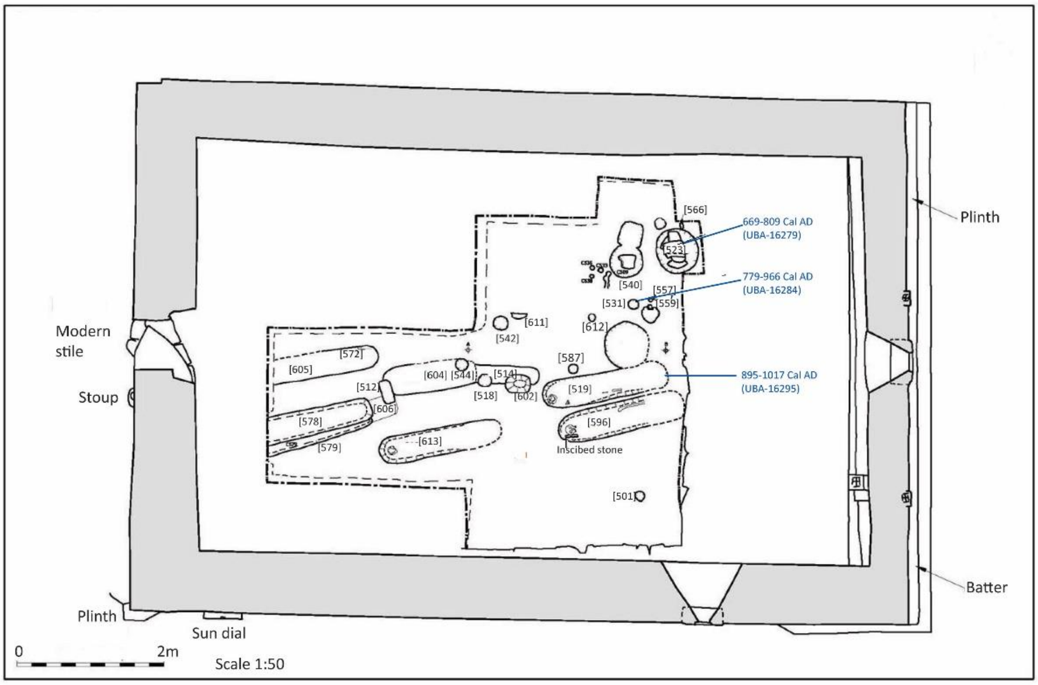


Figure 5.4.7 Trench F (Church plan) showing graves, posts, stakes and other cut features (after O'Carragáin 2008)

5.4.3 Bayesian modelling for Toureen Peckaun, Co. Tipperary

A total of 21 radiocarbon dates from Toureen Peckaun were used to construct a Bayesian model to help refine the chronology of medieval activity recorded at the site **(Table 5.4.1)**. All radiocarbon dates are calibrated in OxCal 4.1, using IntCal 2009 (Reimer et al. 2009). Since many of the features dated were from single phase activities (i.e. post/stakeholes; pits and kilns) across a number of trenches, some of the determinations obtained cannot be placed within a clear sequence and so many of the features identified in Trenches A, B, C, D, E, F and G are difficult to link stratigraphically to each other. Two calendrical dates associated with the site were also incorporated into the model - St Beccán, who died in AD 689/90 (Annals of Inishfallen) and AD 833, a date referenced in relation to Viking raiders arriving at the site (cited in O’Carragáin 2008)

The model constructed gave an overall agreement index of 103 (A_{model} = 102.8 and $A_{overall}$ = 101.8) and so was deemed statistically viable for interpretation **(Table 5.4.2; Figure 5.4.8).** One radiocarbon date from a charcoal deposit pre-dating alluvial layers (1119) under the palisade terminal post and cut the channel in Trench D produced a prehistoric date of 401-209 Cal BC (UBA-16289) and will therefore not be discussed in line with the medieval stratigraphy that superseded it.

To establish a clearer picture of how the early ecclesiastical site at Toureen Peckaun evolved and to understand the chronology and the relationship of features/activities to each other, the site will be discussed in line with the modelled posteriors for the main phases recorded: the construction of an outer enclosure ditch [690] in Trench E and palisade [767] identified in Trench D demarcating the site (Phase 1); inner curvilinear enclosure ditch and internal rectangular buildings in Trench D defining the habitation phase (Phase 2); raised clay deposit (209) in Trench D, cut by a series of postholes and possible metalworking pits /kilns and similar features in Trench B and C (Phase 2/3); the various phases recorded within Trench F associated with the Romanesque church, possible earlier church structure(s) and a sequence of earlier and later burial activity.

Table 5.4.1 Radiocarbon dates from Toureen Peckaun, Co. Tipperary (05E0247)

Laboratory code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Context no.	Context	Material dated	Material species identification
UBA16286	2278	33	401	209	-17.2	1119	Deposit pre-dating alluvial layers – prehistoric Tr. D	Charcoal	Alnus glutinosa
UBA 16285	1555	37	420	584	-23.8	752	Phase 1 terminal palisade post fill [767] Tr. D	Charcoal	Quercus spp.
UBA 16281	1305	40	649	801	-23.4	441	Stake [447] from Phase 2 fence Tr. D	Charcoal	Fraxinus excelsior
UBA 7101	1303	32	658	769	-	159	Fill of a palisade posthole [160] Tr. D	Charcoal	Fraxinus excelsior
UBA 7104	1299	32	660	769	-	39	Uppermost fill of second latest pit [75] cut into backfilled linear feature Tr. C	Bone/antler/tooth	Unidentifed
UBA 7102	1263	32	667	864	-	154	Fill of pit [161/387] near palisade Tr. D	Charcoal	Corylus avellana
UBA 7103	1261	32	668	865	-	129	Principal fill of large linear feature [231] Tr. C	Bone/antler/tooth	Unidentifed
UBA 16279	1263	24	669	809	-27.6	522	Fill of large pit [523] Tr. F	Cremated bone	Burnt bone. Medium-sized mammal long bone fragments.
UBA 7105	1255	31	672	867	-	177	Uppermost fill of pit [224] extension of Tr. C	Bone/antler/tooth	Burnt bone including sheep ph 1, 2 & 3 metapodial fragment
UBA 16280	1255	32	672	867	-25.0	209	Late deposit overlying all the pits at centre of Tr. D	Charcoal	Fraxinus excelsior
UBA 16296	1207	22	724	888	-27.4	654	Basal organic fill of ditch Tr. E	Charred nutshell	Corylus avellana
UBA 16284	1159	22	779	966	-21.9	528	Fill of early rectilinear post Tr. F	Charcoal	Fraxinus excelsior
UBA 16292	1064	43	888	1030	-22.3	421	Phase 1 grave	Bone/antler/tooth	Right temporal.
UBA 16283	1088	22	894	1013	-28.1	508	Fill of post (later) Tr. F	Charcoal	Corylus avellana

Laboratory code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Context no.	Context	Material dated	Material species identification
UBA 16295	1079	26	895	1017	-20.7	519	Phase 1 grave [519] Tr. F	Bone/antler/tooth	Fragment of right maxilla.
UBA 16287	743	30	1223	1289	-14.9	368	Phase 2 grave Tr. F	Bone/antler/tooth	Left temporal
UBA16291	663	26	1278	1390	-21.1	494	Phase 2 grave Tr. F	Bone/antler/tooth	Fragment of left humerous.
UBA 16290	578	20	1310	1413	-22.5	417	Phase 2 grave Tr. F	Bone/antler/tooth	Fragment of left femur.
UBA 16289	429	44	1413	1630	-15.2	384	Phase 2 grave Tr. F	Bone/antler/tooth	Fragment of right tibia.
UBA 16282	451	22	1421	1461	-18.6	502	Small posthole possibly relating to internal partitions of the Romanesque church. (Not 100% secure.) Tr. F	Charcoal	Quercus spp.
UBA 16288	429	21	1435	1630	-20.8	490	Phase 2 grave Tr. F	Bone/antler/tooth	Fragment of right humerous.

Table 5.4.2 Modelled posterior dates for Toureen Peckaun, Co. Tipperary (05E0247)

Toureen Peckaun, Co. Tipperary (05E0247)	**Modelled (AD) 68%**			**Modelled (AD) 95%**			**Model index**	**Index Agreement (A'c = 60.0%)**
	from	**to**	**%**	**from**	**to**	**%**		
Model Agreement (A model) =102.8 (Aoverall) =101.8								
	-227.5	...	68.2	-274	…	95.4		
UBA16286	-403	-210	68.2	-403	-210	95.4	99.2	99
Start_Toureen	610	692	68.2	499	722	95.4		97.5
Early medieval occupation								
Trench D								
Phase 1								
UBA 7101	663	700	68.2	653	750	95.4	106.1	99.8
?old wood content	573.5	...	68.2	574	…	95.4		
UBA 16285	429	546	68.2	416	585	95.4	99.7	99.5
Phase 2/3								
UBA 16281	687	765	68.2	672	771	95.4	99.4	99.8
UBA 7102	694	752	68.2	673	799	95.4	112.2	99.8
Phase 3/4								
UBA 16280	733	865	68.2	715	880	95.4	74.4	99.4
First Trench D	663	700	68.2	653	750	95.4		99.8
Last Trench D	733	865	68.2	715	880	95.4		99.4
Duration Trench D	42	142	68.2	25	196	95.4		99.8
Trench C								
single fill large pit								
UBA 7103	676	722	68.2	667	750	95.4	108.4	99.7
Later pit activity								
UBA 7104	706	769	68.2	680	774	95.4	94.5	99.6
UBA 7105	700	776	68.2	690	870	95.4	96.3	99.6
First Trench C	676	722	68.2	667	750	95.4		99.7
Last Trench C	716	800	68.2	704	874	95.4		99.8
Duration Trench C	13	86	68.2	4	162	95.4		99.8
Trench E Ditch fill								
UBA 16296	774	867	68.2	727	887	95.4	99.5	99.4
first medieval occupation activity	664	694	68.2	655	719	95.4		99.8
last medieval occupation activity	820	880	68.2	770	888	95.4		99.6
span medieval occupation activity	128	198	68.2	83	216	95.4		99.8
Trench F								
first earlier church	788	901	68.2	776	940	95.4		99.6
early church	975	1015	68.2					
burial								
UBA 16292	902	1018	68.2	887	1031	95.4	99.9	99.5
UBA 16295	901	998	68.2	895	1018	95.4	99.4	99.7
Church								

Toureen Peckaun, Co. Tipperary (05E0247)	**Modelled (AD) 68%**			**Modelled (AD) 95%**			**Model index**	**Index Agreement (A'c = 60.0%)**
	from	**to**	**%**	**from**	**to**	**%**		
Early church								
UBA 16284	778	940	68.2	775	951	95.4	100.2	99.6
Later church								
UBA 16283	903	990	68.2	895	1013	95.4	100.1	99.6
first earlier church	778	901	68.2	776	940	95.4		99.6
last earlier church	975	1015	68.2	942	1030	95.4		99.8
end earlier church	1081	1259	68.2	987	1357	95.4		99.4
build Romanesque church	1216	1282	68.2	1151	1380	95.4		99.5
Romanesque church								
UBA 16287	1260	1287	68.2	1237	1385	95.4	93.9	99.5
UBA 16290	1322	1348	68.2	1310	1415	95.4	98.4	99.7
UBA 16289	1429	1460	68.2	1413	1483	95.4	130.9	99.9
UBA16291	1289	1385	68.2	1278	1391	95.4	99.1	99.8
UBA 16282	1432	1449	68.2	1422	1458	95.4	100.1	99.8
Large pit								
UBA 16279	690	768	68.2	668	800	95.4		99.3
UBA 16288	1438	1455	68.2	1430	1470	95.4	107.1	99.8
duration Romanesque	116	200	68.2	63	230	95.4		99.7
first Romanesque	1260	1287	68.2	1239	1383	95.4		99.5
last Romanesque	1440	1463	68.2	1435	1485	95.4		99.8
last use Romanesque church	1446	1485	68.2	1439	1528	95.4		99.7
difference earlier_stone church	-2	234	68.2	-2	240	95.4		99.7
End_TRN	1456	1547	68.2	1445	1669	95.4		96.6
St_Beccan_death	689	690	68.2	689	690	95.4	100	100
Viking raid 833 AD	832	833	68.2	832	833	95.4	100	100
=first medieval occupation activity	664	694	68.2	655	719	95.4		99.8
=last medieval occupation activity	820	880	68.2	770	888	95.4		99.6
=first early church	778	901	68.2	776	940	95.4		99.6
=last early church	976	1015	68.2	942	1030	95.4		99.8
=build Romanesque church	1216	1282	68.2	1151	1380	95.4		99.5
=first Romanesque	1260	1287	68.2	1239	1383	95.4		99.5

By constraining the radiocarbon data for Toureen Peckaun, the model has projected the start date for the site at *610-692 AD (68% probability)* or *499-722 AD (95% probability).* Caution must be observed however, as a date obtained from oak charcoal from posthole [767] (UBA-16285) at the south terminal of the Phase 1 palisade produced a posterior date of *429-546 AD (68% probability)* or *416-585 AD (95% probability).* This sample was questionable due to the 'old wood' effect from oak and so is considered a dubious start date for the construction of the palisade structure. Instead, ash charcoal from posthole [160] (UBA-7101), which produced a posterior of *663-700 AD (68% probability)* or *653-750 AD (95% probability)* is more likely a plausible *terminus post quem* for this structure. The model constrains the later calibration tail for its date (658-769 Cal AD), slightly pushing back the palisade construction by 20-50 years.

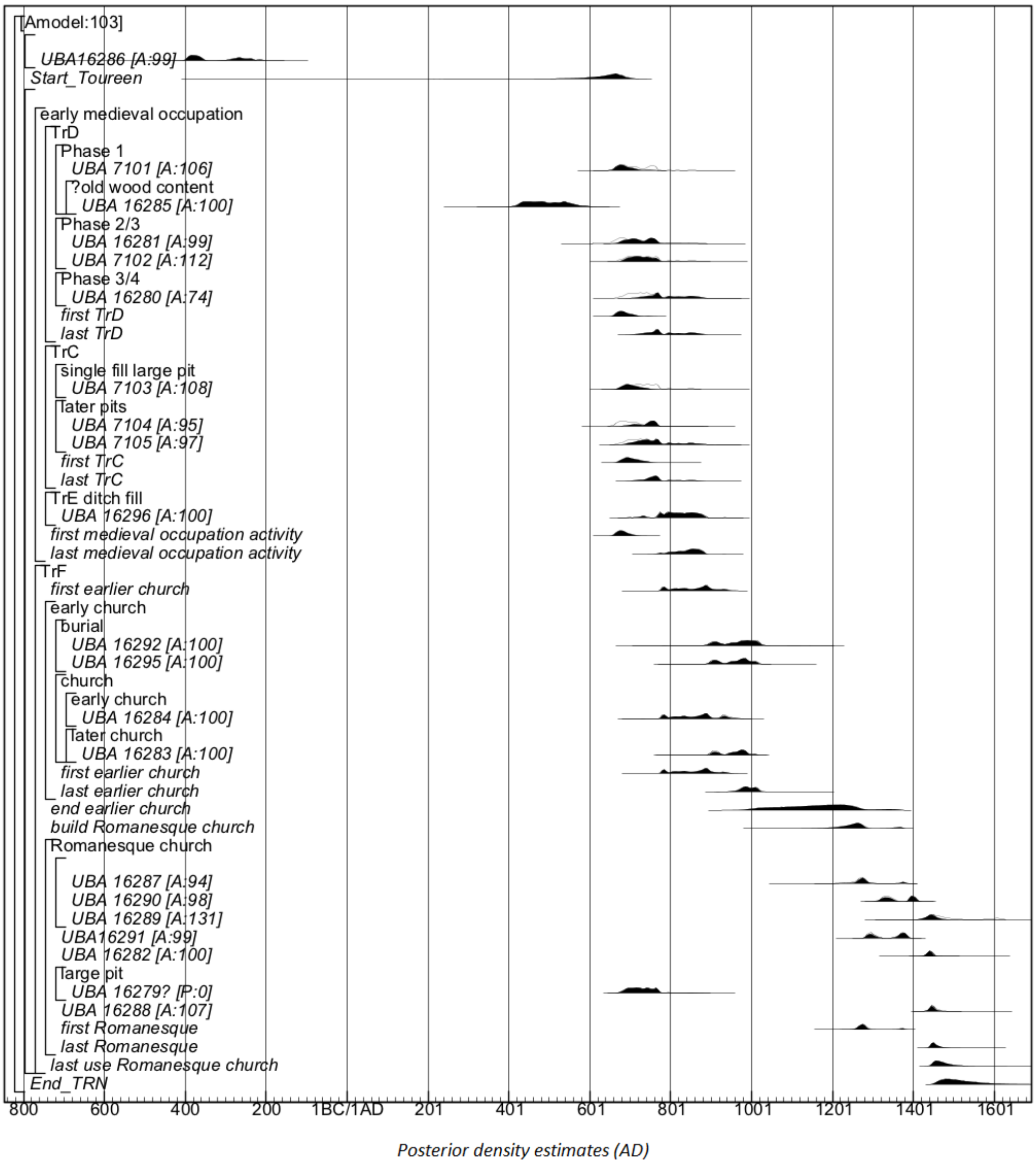


Figure 5.4.8 Probability distribution of modelled dates from Toureen Peckaun, Co. Tipperary

The replacing of Phase 1 palisade with two arcing stave fences (Phase 2) seems to have occurred within a generation or so. Ash charcoal from stakehole [447] (UBA-16281) generated a posterior of *672-770 AD (68% probability)* or *687-765 AD (95% probability)*, which shortened the calibration tail, pushing the construction of this palisade and the possible construction of the buildings within forward by approx. 30-

40 years. A rectilinear pit [161/387] (UBA-7102) located to the northeast of the rectangular structures produced a posterior date of *694-752 AD (68% probability)* or *673-779 AD (95% probability)* and may represent a *terminus ante quem* for this habitation phase. This activity is contemporary with a linear cut feature [231] (UBA-7103) in Trench C, located further west towards the centre of the site, which generated a posterior of *676-722 AD (68% probability)* or *667-750 AD (95% probability).* The exact occupational nature of the latter remains unknown and could not be fully interpreted in line with the habitation features in Trench D.

Cut into [231], a large linear in Trench C, were a series of pits, including [75] and [224], which represents industrial activity at the site, in the form of metalworking and possible corn drying kilns (Phase 2/3). The model has brought forward the dates for these features, producing a posterior of *706-769 AD (68% probability)* or *680-774 AD (95% probability)* for pit [75] (UBA-7104) and *700-776 (68% probability)* or *690-774 (95% probability)* for pit [224] (UBA-7105). Constraining these posteriors together, the model has predicted that the industrial activity in Trench C commenced between *676-722 AD (68% probability)* or *667-750 AD (95% probability)* making it contemporary with the habitation activity in Trench D.

While no radiocarbon dates were obtained from similar features which cut the Phase 2 building layers in Trench D and Trench B to the northwest, it is probable that they form part of this same habitation/industrial phase identified in Trench C. Indeed an early medieval date for activity in Trench B was confirmed by the presence of a polychrome bead and the pin element of a ringed pin (O'Carragáin, 2006). The clay-filled layer (209) (UBA-16280) in Trench D, which sealed many of these pit/kiln features generated a posterior date of *733-865 AD (68% probability)* or *715-880 AD (95% probability).*

The model has pushed the earliest calibration tail for (209) forward by approx. 30 years and could provide a *terminus ante quem* for the activity identified in Trenches C and D, signalling a cessation of the settlement that defined this early medieval phase. A similar range was obtained for an organic fill (654) (UBA-16296) from ditch [690] in Trench E, which produced a posterior of *774-867 AD (68% probability)* or *727-887 AD (95% probability),* making it contemporary with (209) and the end of Phase 3. This ditch, however, was subject to a lot of water action and may have been cleaned out (O'Carragáin, 2008) so the material dated could be incidental in this case.

By collating the posteriors from the all phases of activity (Trenches C and D), the model was able to determine the probability of the start, end and duration for the occupation and industrial phases identified in Trenches C and D. It is proposed that the activities within these areas most likely commenced between *664-694 AD (68% probability)* or *655-719 AD (95% probability)* and ended between *820-880 AD (68% probability)* or *770-888 AD (95% probability)* **(Figure 5.4.9).**

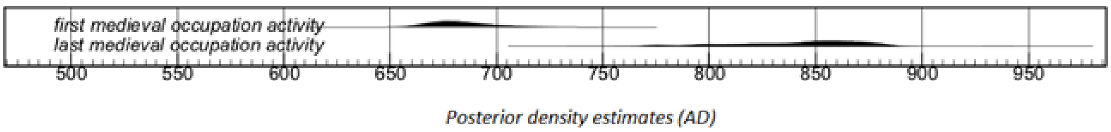


Figure 5.4.9 Probability distribution of modelled dates associated with the earliest and latest phase of occupation activity at Toureen Peckaun

The duration of the activity identified from Trench C is estimated as being between *13-86 years (68% probability)* or *4-162 years (95% probability),* while the activity in Trench D is projected to have lasted between *42-144 years (68% probability)* or *24-196 years (95% probability).* The proposed span of activity from the earliest occupation phase to the end of this early medieval settlement (Phase 1-2/3) overall is therefore quite short, estimated as lasting between *128-198 years (68% probability)* or *83-216 years (95% probability)* **(Figure 5.4.10).**

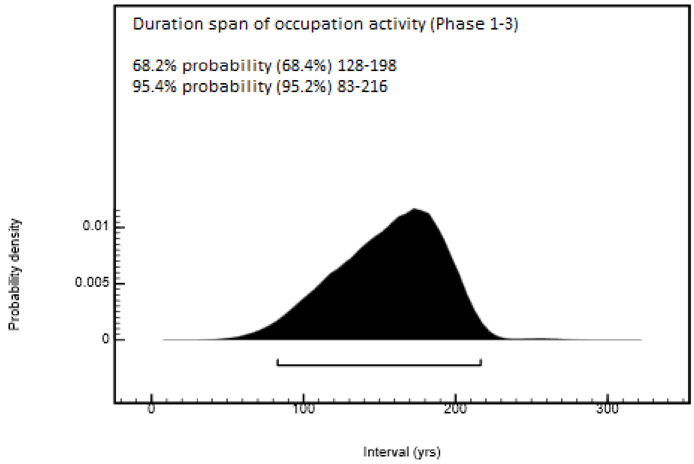


Figure 5.4.10 Duration span of occupation activity (Phase 1-3) in Trench C and Trench D

Figure 5.4.11 below displays the main phases of occupation and church activity from the site in line with the annalistic dates from the death of St Beccán (AD 689/690) and Viking reference (AD 833). When the annalistic date for St Beccán (AD 689/690) is incorporated into the model, it predicts that the earliest occupation at the site predates *AD 689/690* at *73% probability*. This therefore statistically attests that the first occupation phase dated to the late seventh rather than the eighth century AD. It is also more probable than not that the end of this medieval occupation occurs at around the time of the referenced Viking date of AD 833.

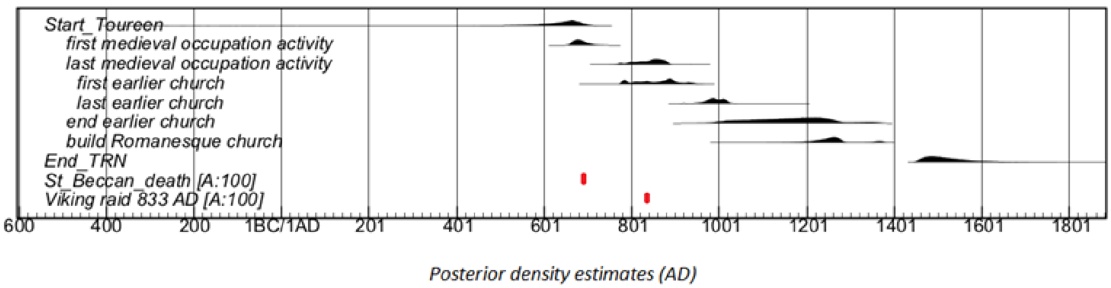


Figure 5.4.11 Probability distribution of modelled dates associated with the main phases identified at Toureen Peckaun

The model postulates that the earliest church activity recorded in Trench F, as defined by [528] (UBA-16284) was dated to *778-901 AD (68% probability)* or *776-940 AD (95% probability).* It must be considered that this earliest activity may be under-estimated in the model because there are not enough samples from this early phase and the construction is more accurately estimated by the calibrated radiocarbon date 770-970 Cal AD (UBA-16284). It is also significant to highlight that the excavations in Trench F were not extensive enough to confirm that earlier church activity contemporary with the formation of the site did not exist.

A slightly later phase, represented by [508] (UBA-16283) and burials [421] (UBA-16293) and [519] (UBA-16295) has been estimated as dating to *976-1015 AD (68% probability)* or *942-1030 AD (95% probability).* The modelled dates associated with the start of the Romanesque church phase itself, and associated burials, generated a date for its construction as being *1216-1282 (68% probability)* or *1151-1380 AD (95% probability).*This phase is projected as ending between *1440-1463 AD (68% probability)* or *1435-1485 (95% probability),* with a duration span of between *116-200 years (68% probability)* or *63-230 years (95% probability).*

The last estimate for the medieval occupation phase predates the earlier church phase at 98% probability. There is a difference of between *5-215 years (95% probability)* or most probably *60-180 years (68% probability)* between the estimate for the last dated medieval occupation activity (Trenches B, C, D and E) and the first estimates for the pre-Romanesque church remains in Trench F. The difference between the end of the earliest church and the construction of the Romanesque church is most probably *160-310 years (68% probability)* or *440-370 years (95% probability)* **(Figure 5.4.12)**.

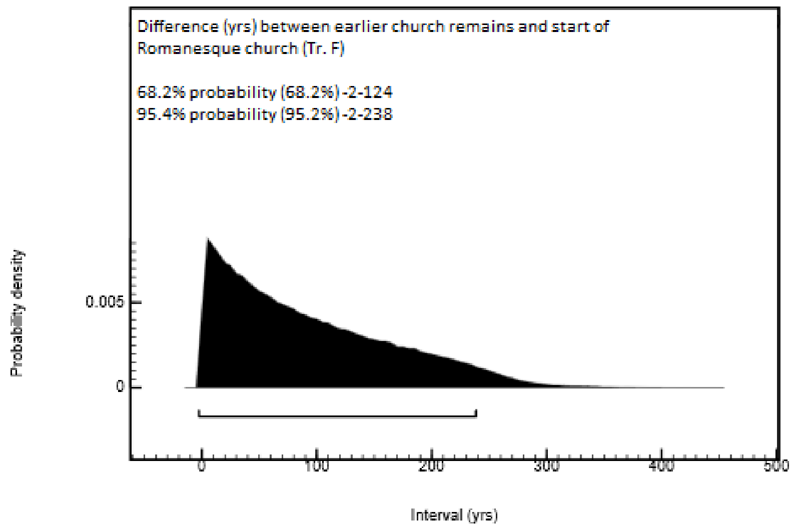


Figure 5.4.12 Difference in years between the earliest church activity and later Romanesque church

5.4.4 Charcoal results from Toureen Peckaun

Ten wood taxa totalling 2,540 charcoal identifications were recorded from the charcoal samples associated with archaeological excavations at Toureen Peckaun, Co. Tipperary. The assemblage was dominated by *Fraxinus excelsior* and *Quercus* sp. accounting for 33% (846 counts) and 31% (790 counts) of the assemblage respectively. *Corylus avellana* made up 19% (482 counts) and *Salix* sp. 9% (230 counts. Lower occurrences of pomaceous woods (Maloideae spp.) and *Alnus glutinosa* were also identified accounting for 4% (85 counts) and 3% (75 counts) of the overall assemblage. *Prunus* sp., *Betula* sp., *Ilex aquifolium* and *Ulmus* sp. accounted for <1% (<15 counts) of the charcoal identified **(Figure 5.4.13).**

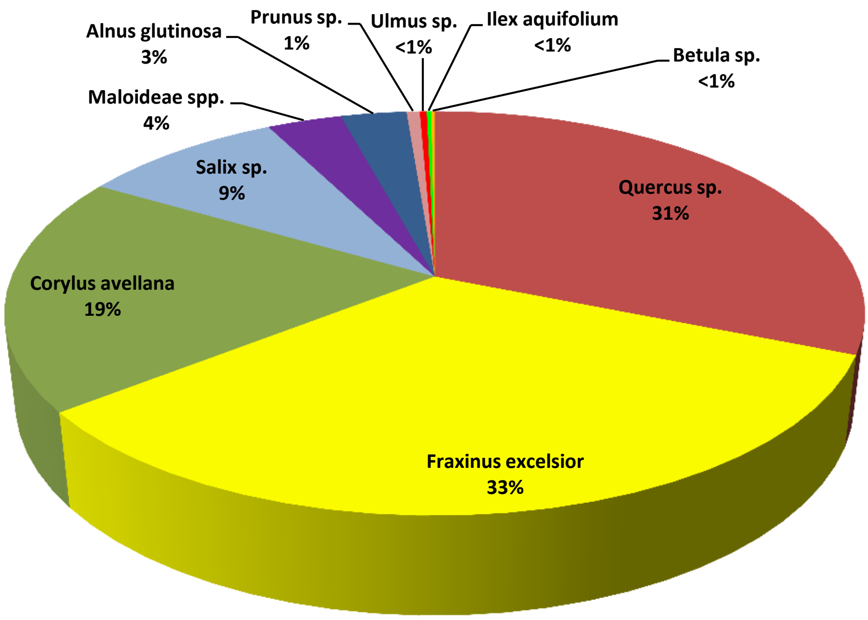


Figure 5.4.13 Percentage of wood taxa from Toureen Peckaun (n = 2,540)

With the chronology of activity at Toureen Peckaun now refined through Bayesian in-depth modelling, the wood taxa from the features defining these phases can now be interpreted more robustly.

Phase 1: Palisade

Phase 1 is characterised by the remains of the enclosure ditch [690] and an enclosing palisade represented by a number of postholes identified in Trench D. Palisade posthole [160] (UBA-7101) produced a posterior date of *653-750 AD (95% probability)* which is interpreted as being the earliest date for occupation at the site.

A sample from posthole [765] contained predominantly willow charcoal with a lower occurrence of ash and oak. The samples from this phase were low in number and confined to just two features, so may not be a good representation of the earliest use of wood taxa at the site. The presence of willow is interesting however, as it has been proposed below that its presence in structural deposits could be deliberate at certain areas of the site which were being effected by or directly associated with water action.

Phase 2: Habitation activity, enclosing palisade and gateway/bridge

The habitational activity defining Phase 2 was concentrated in Trench D, where the remains of a ditch [747], [758] and [883] and a two-stave built palisade/fence enclosing two rectangular structures and associated features were identified. During this phase access to the enclosure was via a bridge and gate at the northwest of the main trench. The evidence for the parallel fences comprised a series of sometimes discontinuous slots into which planks seem to have been set. The charcoal identified from these features revealed some variance in composition **(Figure 5.4.14).** The enclosing palisade, which produced a posterior date of *687-765 AD (95% probability)* from posthole [441] comprised an inner and outer group of stakes, which were joined by a slot at the northern extent [464].

Charcoal identified from a series of inner fence stakes [441], [447], [468] and slot [443] located on the west side contained predominantly or exclusively ash charcoal, with a low incidence of elm also present from [441], while stakehole [297] contained mostly hazel charcoal. A posthole to the north of the palisade [848] contained mostly willow and ash. In contrast, the stakeholes making up the outer extent of the palisade [284] and [423] contained hazel charcoal for the most part, the majority of which were classified as small roundwoods, possibly representing wattling as part of a lighter fence. Willow charcoal, perhaps wattle, was the main wood taxa from posthole [175], which also formed part of this outer arrangement. Slot [464] which connected the two fences to the north contained predominantly oak charcoal.

The dominant ash from the inner fence posts and dominant hazel/willow from the outer fence most likely demonstrates the wood taxa used in its construction. The charred ash wood remains from posthole [447] and fill (468) associated with the western extent of inner fence [174] displayed weakly curved rings, denoting the use of larger posts, with possible hazel wattling from posthole [285]. A gate slot [928] located at the west of the ditch, and functioning as an access route into the enclosure, contained oak charcoal only, suggesting this was the wood type used in its construction. Two deposits (741 and 745) from the enclosing ditch [747] were dominated by hazel, willow and oak charcoal, the majority of which (60%) were classified as small branchwood (<30mm diameter). This strongly indicates wattling, perhaps representing the remains of a pathway or hurdle used within the ditch as a way of crossing into the enclosure.

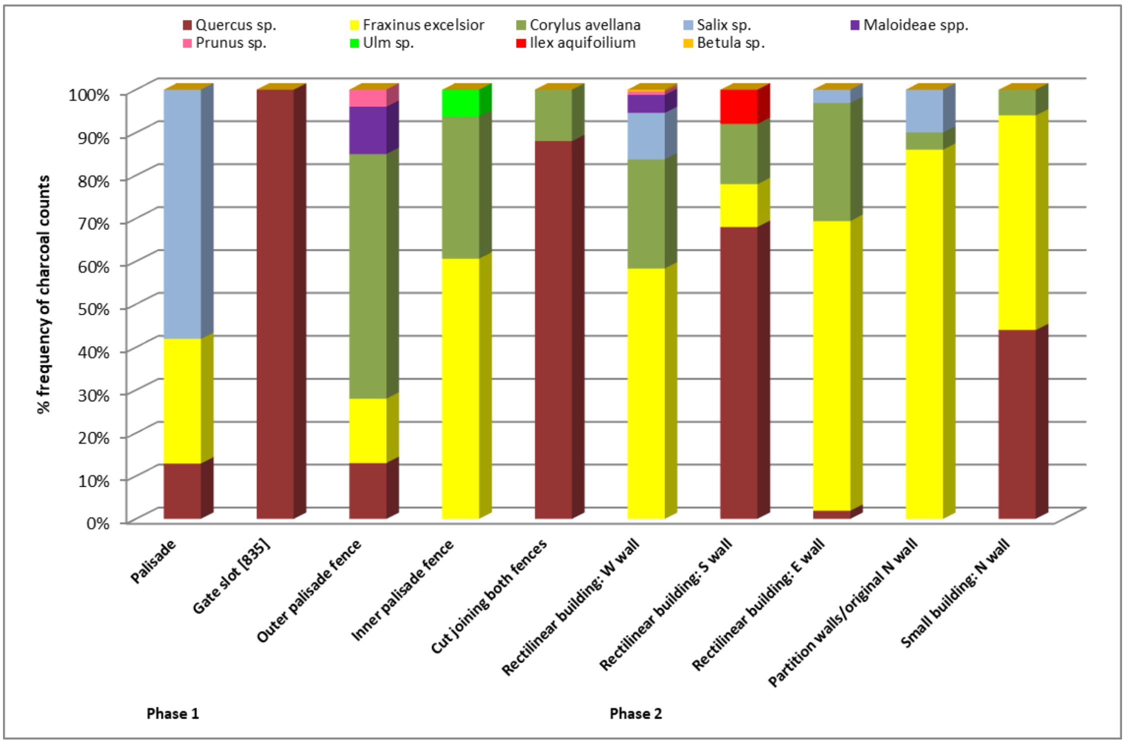


Figure 5.4.14 Distribution of wood taxa from Phase 1 and Phase 2 at Toureen (Trench D) (n= 988)

A series of postholes [370, 418, 728, 740, 744 and 875] and a linear slot [996] associated with the central rectangular building comprised of three main wood taxa interpreted as being the main fabric of the structure. Ash was the dominant species from west wall posthole [875], east wall posthole [418] (lower fill 392) and slot [996]. Posthole [744] from the west wall and posthole [370] from the south wall contained high oak charcoal, with hazel the dominant taxa identified from west wall posthole [710]. Posthole [740] cuts into [710] and may represent a rebuild of the structure as ash was the dominant charcoal identified from [740], along with lower incidences for hazel and Maloideae wood species. Similarly, an upper and distinct fill (292) of posthole [418] from the east wall may represent a replacement of the original post (392), where hazel replaced ash in this section of the building. The excavation noted that a series of postholes located just west of [418] may represent repair to the structure, ash being the dominant taxa from posthole [967]. This together with the reuse of [418] and [710/740] shows that the W and E section of the building was repaired at least once during its lifetime. A smaller rectilinear structure built at the SE corner, leaning against the fences was found to contain predominantly oak from central posthole [342] and hazel from posthole [207], located along the north wall.

Just north of this and to the east of the main rectangular building was a large pit with a superstructure [161/387]. A pit [318], which cut the latter contained mostly ash charcoal, with a lower frequency of hazel. Other taxa worth mentioning that formed part of the charcoal cache (elm, holly, birch, willow, Maloideae spp. and *Prunus* spp.) are considerably lower, which is unusual somewhat but may reflect the types of features sampled (posholes). Their relative presence from structural deposits is generally incidental, being re-deposited detritus from on-site hearths and firing activities. Since no hearths were recorded at the site (O'Carragáin, 2008) it is difficult to fully ascertain the primary source of this material, however they signal the array of wood species being used or brought to the site.

The charcoal samples were largely confined to structural features and deposits associated with well-defined pits and deposits. The results revealed that oak most probably formed the main fabric of the gateway into the enclosure, the westernmost and southernmost post of the rectangular building [370 and 744] and the central post of the small rectilinear building [342]. It was also likely to have been used in the slot [484] adjoining both the inner and outer fences at the north end of Trench D. This use of oak at significant junctions or centre points on the site serves to demonstrate the investment in these construction works, where there was a need for greater stability or durability for specific focal points. Ash was used as the main wood in the construction of the larger structure and most likely the smaller building, and was predominantly used in the inner palisade to the west. This taxon also found its way into other occupation deposits across the site, highlighting its frequency or use during this phase. Some repair to the west and northern extent of the central rectangular building was also noted, where hazel and ash was used. Small roundwoods of hazel and willow were found in the enclosure ditch [747], interpreted as the remains of possible hurdles/pathways, with hazel roundwoods dominating many of the outer palisade postholes and willow in the structural deposits of the northern fence. This strongly indicates that the outer fence had elements of wattling or horizontal rods inter woven between larger vertical posts (or sails). Considering the efforts made to divert and manage the stream channel that ran through the site, the outer fence may have been constructed to reinforce the inner more formidable ash fence perhaps functioning as a type of embankment to protect this extent of the palisade from water erosion. This type of wattled palisade fencing has been found on crannóg sites, constructed as an outer barrier or breakwater against the surrounding water action (Halpin and O'Sullivan 2000, 33).

Phase 2/3: Industrial activity

The industrial or working areas (e.g metalworking and corn drying) identified in Trenches C have been postulated as overlapping with the habitation phase (Phase 2) based on the posteriors for this activity (*667-750 AD, 95% probability*). It seems likely then that this industrial activity commenced to the east (Trench C), just outside the enclosure that delimitated the habitation area but was later repositioned or expanded into Trench D once the buildings here went out of use (Phase 2/3). The activity identified in Trench B to the NE was interpreted as contemporary, highlighting another area of use at the site. The end of the industrial phase and hence the cessation of this early medieval occupation has been projected as occurring at *715-880 AD (95% probability).* The duration of time from the start of Phase 2 habitation and the end of the industrial activity (Phase 3/4) was therefore short-lived, predicted as lasting no more than *196 years (95% probability).*

While it was difficult to interpret the features from Trench B with those from Trench C and D, the wood composition identified from a series of pit and drain features is worth discussing **(Figure 5.4.15).** While ash, oak and hazel were all identified in varying frequencies, one of the most interesting aspects of the results from this part of the site is the notable presence of alder and willow charcoal. Indeed, this is the only trench that contained alder, a wood species that is commonly being associated with ditch features interpreted as containing water within this study (see **4.3.4** and Hughes' Lot East **5.3**). With this in mind it is worth noting that the excavation revealed some augmentation to this part of the site, where clays and stone deposits were introduced to build up primary layers (O'Carragáin, 2008). The presence of alder and willow here may then reflect the remains of a fence or palisade used to counteract waterlogging or some degree of water action at this part of the site.

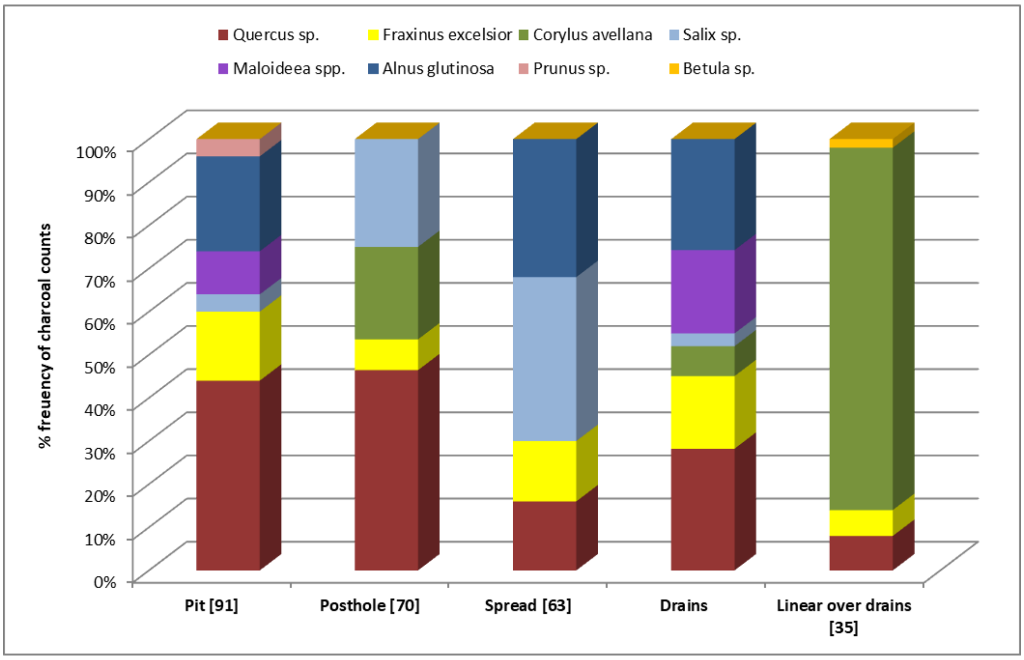


Figure 5.4.15 Distribution of wood taxa from Trench B features (Phase 2/3)

5.4.5 Overview of wood results from Toureen Peckaun

Since the habitation phase (Trench D) and the start of the industrial phase (Trench C) are likely to be contemporary or occurred shortly after the demise of the buildings, the wood taxa identified from the charcoal record make for interesting interpretation. Ash is the only wood taxa identified from postpipe [19] and linears [176] and [231] in Trench C, which is essentially the wood of choice for the majority of the contemporary construction works in Trench D. As the industrial phase expands and supersedes the habitation phase in Trench D, there is a notable rise in oak charcoal from features pertaining to possible corn drying kilns and metalworking [682, 721, 843, 892 and 989] and later pits and deposits overlying the habitation layers in Trench D [340, 320, 948 and 992] **(Figure 5.4.16).** With the exception of the final occupation phase [726], which contained ash, willow, birch and hazel, many of the minor occurring taxa identified from the habitation phase were not recorded from the industrial features. This is also supported by the statistical analysis **(Figure 5.4.17).** and correlation values **(Table 5.4.3),** where oak use is distinct from all other wood taxa at certain times during occupation at the site.

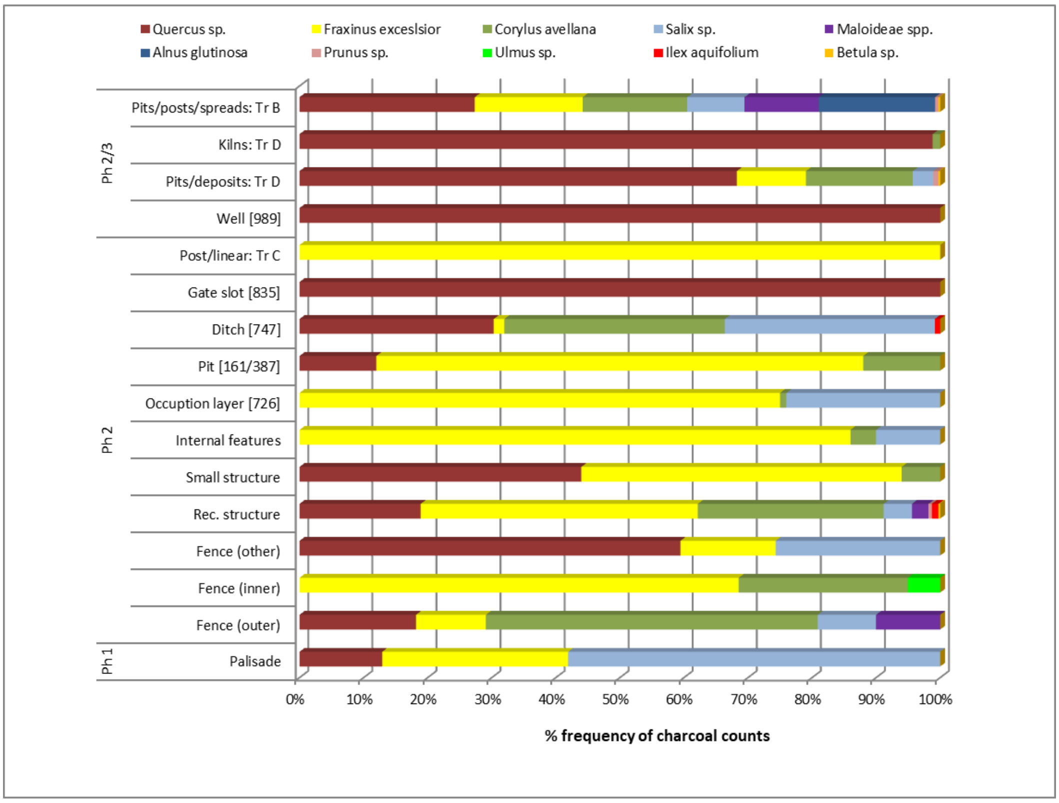


Figure 5.4.16 Distribution of wood taxa from each phase of activity at Toureen (n = 2,540)

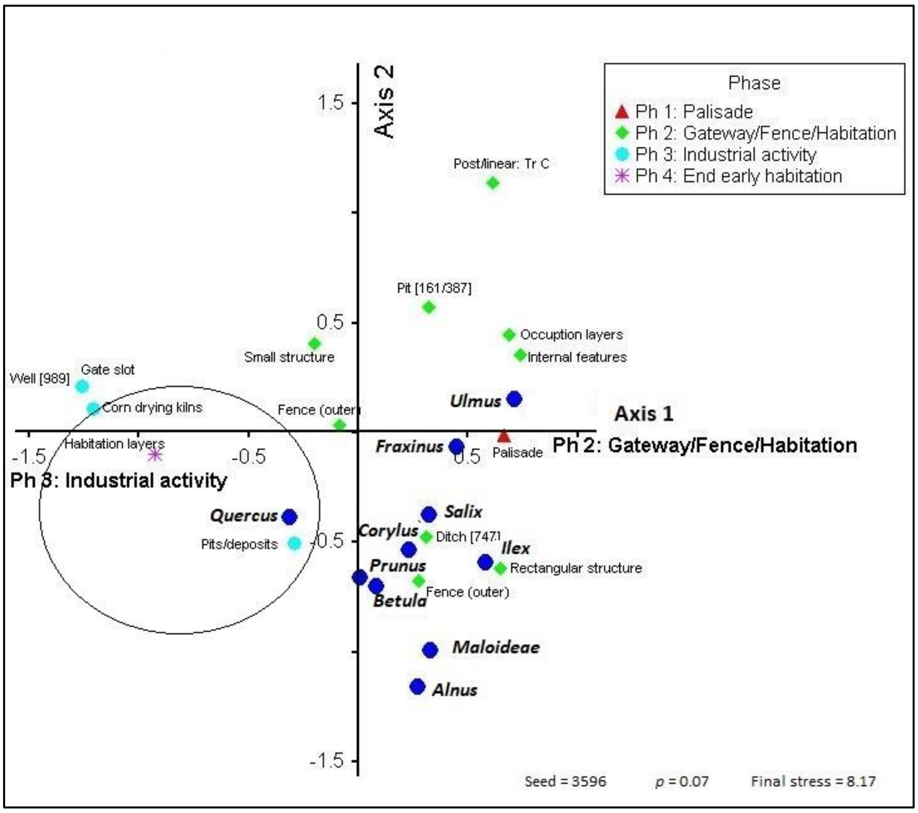


Figure 5.4.17 NMS Axis 1v2 ordination of combined samples from Toureen Peckaun

Table 5.4.3 Correlations (Pearson's *r*-value) of explanatory variables (values in red are statistically significant at p<0.05 level for two-tailed t-test)

Taxon	Axis 1 *r-value*	Axis 2 *r-value*	Axis 3 *r-value*
Quercus sp.	**0.231**	-0.365	-0.229
Fraxinus excelsior	-0.59	-0.081	-0.534
Salix sp.	-0.418	-0.605	0.369
Maloideae	-0.158	-0.641	-0.24
Corylus avellana	-0.216	-0.682	-0.386
Alnus glutinosa	-0.097	-0.495	-0.236
Ulmus sp.	-0.256	-0.08	-0.605
Ilex aquifolium	-0.242	-0.315	-0.085
Betula sp.	-0.053	-0.515	-0.338
Prunus sp.	-0.008	-0.444	-0.306

Oak v Ash

The obvious shift to a dominate oak is a significant transferral of wood resource use, as it not only signals the wood selection strategy now being employed for specialised activities, but possibly highlights the changing priorities at Toureen over a short period of time. An interesting observation is the decrease in ash charcoal, for example, a wood commonplace during the habitation phase at the site, particularly construction works and the early stages of activity in Trench C. The opposing use or complimentary nature of oak and ash is arguably becoming a distinct feature of the charcoal assemblages from other contemporary sites in this study, such as Hughes' Lot East and as **Figure 5.4.18** below shows, their relative usage at Toureen is somewhat conflicting, where oak values are high, ash is low and vice versa.

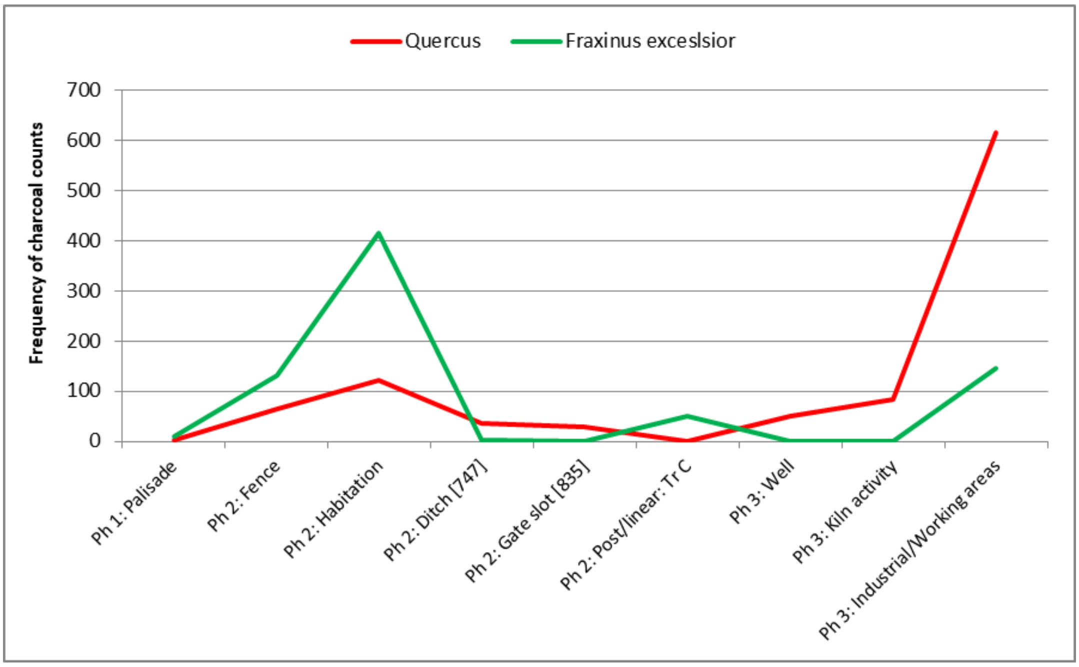


Figure 5.4.18 Comparisons between frequency of *Quercus* (oak) and *Fraxinus* (ash) from Toureen Peckaun (n = 1,748)

As the industrial phase continues after the last phase or habitation, oak becomes the dominant taxa used. This seems to demonstrate that oak availability was sporadic at Toureen between the late seventh to late ninth century, with preferential use for certain robust elements only (i.e. supporting posts and gateway structure) and priority given instead to specialised activities, such as metalworking when in use. This implies then that oak was probably a valuable commodity, where functionality determined its relative use. If oak supplies were scarce during this time, then activities, such as metalworking were taking precedent over building. Oak may not have been fully accessible or abundant to the settlement at Toureen at certain times, which raises some interesting questions about wood resource management, distribution and local availability at the site between the seventh to the ninth century AD.

5.5 Corn drying kilns

5.5.1 Introduction

To investigate activity related wood use through the charcoal record, the corn drying kilns were selected as a feature case study to establish any changes or similarities in context-related wood variance over time. A total of fifty-one kilns were analysed as part of this thesis and to date forms the first comprehensive study of charcoal remains from corn drying kilns in an Irish context **(Plate 5.5.1).** A significant pattern emerging from the charcoal dataset associated with these kilns is the shift in wood variance from the earliest dated kilns, c. fifth century AD through to the tenth century AD and later into late medieval period. The three main phases observed through PFA were the hazel dominant charcoal assemblage defined by the fifth century dated kilns; a mixed wood assemblage defined by a rise in ash and fruitwood species (Maloideae and *Prunus* species) from c.sixth to the tenth century kilns and the increase in oak use in kilns from c.tenth century AD onwards **(see Chapter 4; Section 4.3.4).**

This section of the chapter will present the corn drying kilns as an appropriate case study by placing them into context using the archaeological and historical record. To create a theoretical framework within which to discuss the major shifts in wood use observed thus far, a Bayesian model presents the posteriors generated for each kiln to provide a more robust chronological sequence of wood use activity for the medieval period. Considering that corn drying kilns have a symbiotic relationship with other on-site activities and are shown to reflect discreet changes in wood use over time, this approach has the ability to provide dating parameters within which to discuss the factors that influenced wood selection strategies during the medieval period. In turn, this also has the potential to help with discussing if changes in wood variability, identified through the charcoal record, is closely related to when changes are seen to occur in the organisation and re-organisation of rural medieval settlement patterns and the socio-economic structures that underpinned them.

One key question of interest with regard to corn drying kilns is to explore if particular wood taxa were being selected to dry certain species of grain (the charred cereal remains left *in situ* after a kiln has burnt down). This novel approach of comparing charcoal data with plant macrofossils has not been attempted in the context of Irish archaeological material and so the results will help with identifying if wood selection for kilns was context related or, as seen thus far, if kiln fuel was indeed influenced indirectly by varying degrees of wood availability congruent with other on-site activities.

Above: Monadreela Site 11, Co. Tipperary, kiln [38] 394-551 Cal AD (UBA14372) (O'Brien & O'Droma 2014c)

Above: Kellysgrange Site 3 , Co. Kilkenny, kiln [4] 615-671 Cal AD (UBA-12182) (Kyle & Coughlan 2011b)

Above: Ballykeoghan AR26, Co. Kilkenny kiln [149] 679-869 Cal AD (UBA13980) (Wren 2010)

Above: Boscabell Site 19, Co. Tipperary, kiln [184] 1030-1172 Cal AD (UBA-13743) (O'Brien & O'Droma 2014e)

Above: Coolmore AR44, Co. Kilkenny, kiln [3] 1216-1268 Cal AD (UBA14005) (Monteith 2010c)

Above: Leggetsrath East Site 1, Co. Kilkenny kiln [276] 1303-1411 Cal AD (UBA15447) (Devine & Coughlan 2013)

Plate 5.5.1 Examples of medieval corn drying kiln analysed as part of this study

Table 5.5.1 List of corn drying kilns and wood taxa identified from this study

Site name	Context no.	*Quercus*	*Corylus avellana*	*Fraxinus excelsior*	*Maloideae*	*Salix*	*Prunus spinosa*	*Prunus avium/padus*	*Prunus type*	*Alnus glutinosa*	*Betula*	*Ilex aquifolium*	*Taxus baccata*	*Ulmus*	*Euonymus europaeus*	*Frangula alnus*
Gortmakellis	Kiln [19]	23	9	9	26	17	0	0	0	4	1	0	0	0	0	0
Gortmakellis	Kiln [118]	11	4	10	38	18	0	0	0	0	4	0	0	0	0	0
Ballydavid	Kiln [287]	27	137	0	0	9	34	0	3	0	0	0	0	3	0	0
Monadreela Site 5	Kiln [155]	0	21	79	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	Kiln [187]	13	21	1	14	2	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	Kiln [38]	38	45	0	7	2	0	8	0	0	0	0	0	0	0	0
Hughes' Lot East 25ii	Kiln [401]	7	87	36	0	0	0	4	0	4	0	0	0	0	0	0
Hughes' Lot East 25ii	Kiln [795]	15	2	153	24	0	17	0	7	0	8	5	0	0	3	0
Hughes' Lot East 25ii	Kiln waste [423]	27	23	18	13	26	0	8	0	5	0	0	0	0	0	0
Hughes' Lot East 25ii	Kin [308]	0	45	1	39	8	0	57	0	0	0	0	0	0	0	0
Hughes' Lot East 25iv	Kiln [148]	63	17	6	10	0	5	0	0	6	0	0	0	0	0	0
Hughes' Lot East 25iv	Kiln [150]	161	12	5	0	0	0	0	0	0	0	0	0	0	0	0
Bosacbell Site 19	Kiln [183]	50	9	0	0	0	0	0	4	0	1	0	0	0	0	0
Borris AR33	Kiln [1145]	73	37	0	27	5	0	0	5	0	0	0	0	0	5	0
Borris AR33	Kiln [525]	8	4	0	40	0	0	0	0	0	0	0	0	0	13	0
Borris AR33	Kiln [920]	16	29	3	31	16	0	0	0	0	0	0	0	0	17	0
Borris/Blackcastle AR31	Kiln [91]	0	115	0	0	0	7	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	Kiln [660]	47	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	Kiln [1758]	40	23	0	57	15	0	0	4	0	0	0	0	0	13	0
Kellysgrange	Kiln [3]	0	5	0	42	0	1	0	2	0	0	0	0	0	0	0
Kellysgrange	Kiln [4]	5	62	9	31	5	17	16	0	0	0	2	0	0	0	0
Kellysgrange	Kiln [5]	0	0	2	30	2	1	2	0	2	0	0	0	0	0	0
Kellysgrange	Kiln [6]	29	13	18	6	0	16	6	0	0	0	0	0	0	0	2
Kellysgrange	Kiln [7]	3	34	3	3	0	5	0	0	0	0	0	0	1	0	0
Kellysgrange	Kiln [8]	1	44	11	16	1	5	6	0	5	0	1	0	0	0	0
Kellysgrange	Kiln [9]	4	4	31	10	0	0	0	0	1	0	0	0	0	0	0
Kellysgrange	Kiln [40]	0	37	0	10	7	22	9	0	0	0	1	0	1	0	0
Kellysgrange	Kiln [43]	34	8	0	4	0	0	4	0	0	0	0	0	0	0	0
Holdenstown Site 1	Kiln [159]	20	157	29	1	0	0	0	12	0	0	0	0	19	0	0
Templemartin	Kiln [3]	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
Baysrath AR53/54	Kiln [4]	1	0	3	16	0	0	0	12	4	0	0	0	0	0	0
Baysrath AR53/54	Kiln [15]	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Coneykeare	Kiln [21]	25	21	1	0	0	0	0	0	3	0	0	0	0	0	0
Leggetsrath East	Kiln [220]	19	0	1	0	5	0	0	49	0	0	0	0	0	0	0
Jordanstown	Kiln [C4]	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milltown Site 3-5	Kiln [81]	8	5	10	4	0	0	0	5	3	0	0	0	0	0	0
Milltown Site 3-5	Kiln [122]	0	5	3	1	0	0	0	0	0	0	0	0	0	0	1
Ballykeoghan	Kiln [7]	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ballykeoghan	Kiln [149]	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ballykeoghan	Kiln [221]	41	5	1	0	0	0	0	0	0	0	3	0	0	0	0
Scart	Kiln [3]	30	2	0	4	0	0	0	9	0	0	1	0	0	0	0
Scart	Kiln [15]	73	17	16	4	0	0	0	2	0	1	2	1	0	0	0
Scart	Kiln [53]	60	1	5	0	0	0	0	10	0	0	0	0	0	0	0
Kilree Site 3	Kiln [395]	16	0	0	0	0	37	0	20	0	0	0	0	1	0	0
Kilree Site 3	Kiln [465]	7	1	21	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 4	Kiln [66]	0	68	5	0	0	12	0	8	0	0	0	0	0	0	0
Kilree Site 4	Kiln [312]	1	0	0	65	0	15	0	0	0	0	0	0	0	0	0
Knockadrina	Kiln [537]	40	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Shankill Site 2	Kiln [27]	64	0	0	0	2	0	0	0	0	9	0	0	0	0	0
Scart/Rahard	Kiln [50]	47	2	0	0	0	0	0	0	0	1	0	0	0	0	0
Coolmore	Kiln [7]	310	0	0	0	0	0	0	0	0	0	0	0	0	0	0

5.5.2 Background to corn drying kilns

Grain-drying kilns were in use along the fringes of Atlantic Europe from the prehistoric period until the late-nineteenth century, when they were gradually replaced by more advanced grain-drying machinery (O'Sullivan and Downey 2005). These features have been variably recorded – and at times ambiguously interpreted -- as “hearths”, “ovens”, “malting kilns/ovens”, “crop-drying kilns” or “grain-drying kilns/ovens” (Moffett 1989, 1994, Heaton 1992). They are a north-western ‘coastal’ European phenomenon, with archaeological examples known from Romano-British through Anglo-Saxon and later medieval periods in Britain (Hamerow 2012, Ross et al. 2017). Examples include those at Houghton Down and Fullerton in Hampshire dating to the fourth-fifth century AD (Campbell 2008a, 2008b), mid-Saxon examples at Chantry Fields, Gillingham, Dorset (Heaton 1992), the eighth century ecclesiastical site at Hoddom, in the south-west of Scotland (Lowe and Brooke 2006) and Bamburgh Castle, Northumberland (Young 2003) in addition to their historical reference in an eleventh century source called the *Gerefa* (The Reeve) (C. Rynne pers. comm.). It is possible that this cultural phenomenon arrived to Ireland from Britain during the Roman period. Apart from Bronze Age examples identified at Knockgraffon, Co. Tipperary (McQuade et al 2009, 33) and Carrigtogher (Harding), Co. Tipperary (Hackett 2010, 34) for example, they are generally rarely recorded prior to the late Iron Age in Ireland.

To date it is estimated that well over 1000 corn drying kilns have been recorded and excavated in Ireland, the majority of which have been radiocarbon dated to between the fifth to the thirteenth century AD, with a peak during the early medieval period between the sixth to the ninth century AD (Monk and Power 2012). They now rank second to *fulachta fiadh* as one of the most numerous and well-recognised features in the Irish archaeological record. While their distribution is widespread, the majority of medieval kilns have been recorded from counties Kildare, Kilkenny, Meath and Tipperary **(Figure 5.5.1).**

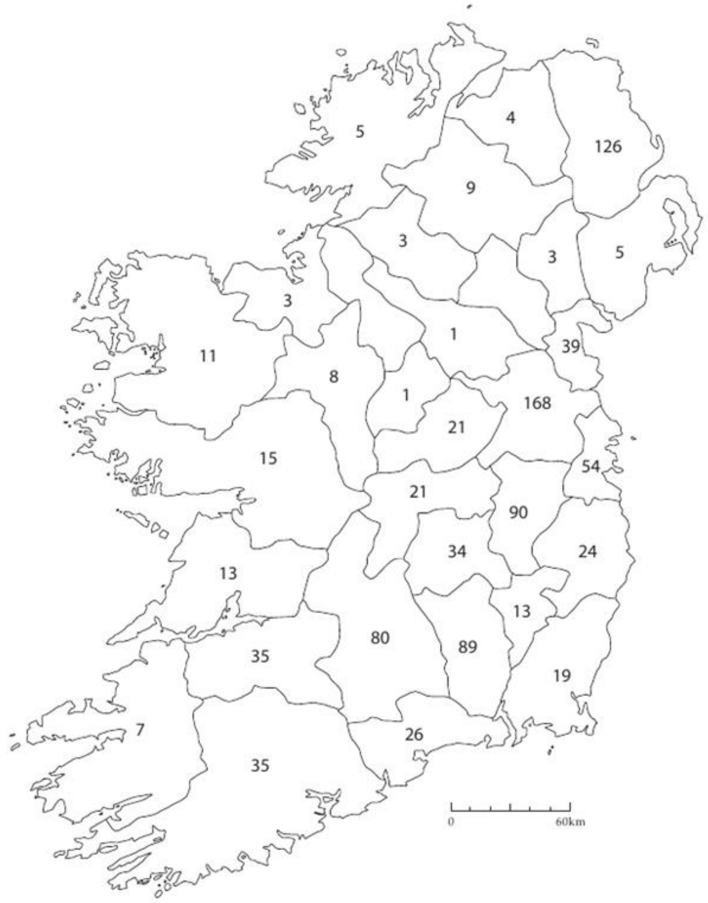


Figure 5.5.1 Number of corn drying kilns identified per county in Ireland, as of 2010 (numbers based on www.excavations.ie)

The upsurge in kilns from the early medieval period has been postulated as being the result of a damper climate, although this is still questionable (ibid.). However, considering the documentary sources and palaeoclimatic proxy data, the climatic downturn in the eighth and ninth centuries arguably coincides with an upsurge in arable agriculture during this time, possibly as a response to a shift away from a cattle-based economy which relied on all-year grazing (Kerr et al. 2009). Alternatively their rise may have been a response to changes in the scale of crop production to meet demands for more food for a growing population and/or to meet social obligations (Monk and Kelleher 2005, 77).

The primary motive for drying grain is based on a) the exact place of the harvest time within the seasonal cycle, b) the stage of maturity of the grain at harvest and c) the form under which the grain will be put into storage (Hillman 1981, Hillman

1984). Other reasons for drying grain include; to aid threshing; the removal of glumes from hulled grain; to kill the germinating grain after malting; improve the storage properties of the grain (killing pests and driving off excess moisture) (Scott 1951, Monk 1983). The dampness of the Irish climate made it especially important that grain be artificially dried before it was stored as wet grain spoils easily and difficult to mill (Kelly 1997, 241).

5.5.3 Archaeological research on corn drying kilns

Studies on their form and function traditionally used folklore evidence and the ethnographic literature (Scott 1951, Whitaker 1957, Gailey 1970, Fenton et al. 1974, Fenton 1997, Rickett 1975, Bowie 1979). More recently, research agendas in Ireland have focused on experimental reconstruction to understand their inner workings and functionality (Monk and Kelleher 2005) their chronology and development (Timpany et al. 2011, Monk and Power 2012, 2014) and the charred plant macrofossils (grains/chaff/weed seeds) that are commonly recovered from these features (Monk 1985, Holden 2006, McCormick et al. 2011, Power 2011, McClatchie et al. 2015a, Blakeney 2017). Attention has largely been on the archaeobotanical material recovered from corn drying kilns and the *Early Medieval Archaeological Project (EMAP)* has undertaken seminal work in consolidating this information for the purpose of understanding early medieval arable agricultural practices within a broad geographical and chronological framework (McCormick et al. 2011, O'Sullivan et al. 2013).

In terms of studying past crop production and the different cereals represented, corn drying kilns provide a reliable picture of medieval arable agricultural practice. In the processing of grains post-harvest crops may become carbonised intentionally or accidently, thus providing a snapshot of grain cultivation through the lifetime of the kiln and leaving its signature in the archaeological record. The kiln superstructure and furniture being made of wood and other organic materials were highly flammable, so grain may have become burned during the drying process due to a conflagration event.

The intentional burning of grain is also well documented in Ireland as a pre-winnowing activity a process of scorching the grain in the ear known as 'graddaning' (Estyn Evans 1957, 81). These charred remains, which are often left *in situ* after a kiln has been abandoned, or levelled or dumped into open features as domestic debris (McCormick et al. 2011), are direct evidence of this arable practice, the study of which has improved our knowledge of this evanescent technique. These well-defined features are almost always radiocarbon dated and through the use of short-lived material (grain), are delivering a robust dating profile of use, re-use and abandonment (e.g Ratoath, Co. Meath (Wallace 2010a))

There now exists an impressive corpus of archaeobotanical evidence from well-dated medieval kilns, however, prior to this study, the charcoal component from these features was largely under-researched and confined to the grey literature or published as part of a site report. O Carroll's doctoral research (2012) includes them as one of the feature types analysed for charcoal remains, however, they were under-represented in her study area, with just two later medieval kilns recorded (Tonaphort and Clonfad 3 in Co. Westmeath) (ibid. 58). The charcoal analysed is therefore not a good representation of the broader feature-set and the results are confined to just those kilns within the context of the sites excavated.

5.5.4 Archaeological evidence for corn drying kilns

In archaeological terms, kilns vary in size and shape, some are lined with stones, flags or simply clay cut, but all identifiable examples consist of three constituent parts -a furnace/stoking area with a flue of varying length that supplies hot air to the drying chamber or bowl (O'Sullivan and Downey 2005, Monk and Kelleher 2005) **(Figure 5.5.2)**. Archaeologists have defined kilns by their shape in plan, and there are five major typological groups – keyhole-shaped; figure-of-eight shaped; dumbbell shaped; 'L'- or comma-shaped; and pit/irregular shaped kilns (Monk and Kelleher 2005, 80). This typology is not absolute and there can be considerable overlapping of the types (ibid. 80). The figure-of-eight kilns predominate in the earlier centuries, but co-occur with keyhole-shaped kilns, which have a longer flue. It has been argued that an increase in the latter type in later centuries was a practical move, as a longer flue made them less susceptible to catching fire (Monk and Power 2012).

Corn drying kilns are now found on a variety of settlement complexes - multi-enclosure settlements and settlement-cemetery sites and often in multiple groupings, such as those at Rosepark, Balrothery, Co. Dublin; Dowdstown, Co. Meath;

Raystown, Co. Meath; Johnstown 1, Co. Meath; Baronstown, Co. Meath (all referenced in O'Sullivan et al. 2013), Killalane, Co. Tipperary (Long 2009, 19-28) and Hughes' Lot East, Co. Tipperary (O'Brien 2013) as part of this study. While evidence from the early Irish sources describe in detail the components of the enclosed domestic space (*les)*, which includes a corn drying kiln (*áith)* (Kelly 1997, 363), the increasing evidence through the archaeological record is showing groups of kilns being located outside the main enclosures of the settlement (Flynn 2009, 135).

This area, known in the texts as the *airlise* (Kelly 1997, 368) has been previously under-researched, however, the increase in archaeological excavations have explored these areas with some interesting results. The identification of extramural houses (at Brokerstown, Co. Antrim; (Kerr 2010, 25-26) laneways and fields (e.g. Dowdstown, Co. Meath; (Cagney 2009), corn drying kilns, ironworking areas, ditches and palisaded structures possibly associated with cultivation plots, gardens or small enclosures for livestock have all been identified (O'Sullivan et al. 2013, 228).

Since kilns were notable fire hazards their location away from the main settlement and dwelling house would be necessary and indeed the early law tracts stipulate that they be situated a certain distance away (Evans 1957, 123), as some Irish examples can attest (O'Sullivan et al 2013,). In addition, some kilns appear to be found on isolated sites, completely disassociated from any settlement, such as the eight kilns recorded from Kellysgrange, Co. Kilkenny (Kyle and Coughlan 2011) from this study. The group of four figure-of-eight kilns at Loughanstown, Co. Dublin, is several hundred metres from the nearest early medieval settlement (Seaver 2005, 51) and at Lowpark, Co. Mayo, a kiln dated to the tenth- to twelfth-century is some 250m outside an early medieval enclosure (Gillespie and Kerrigan 2010, 277-281).

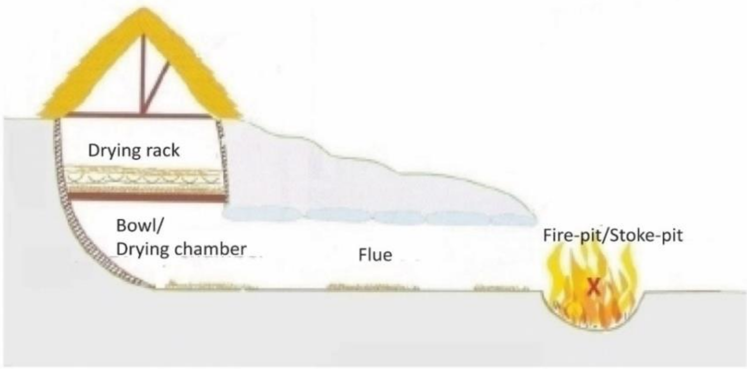


Illustration showing cross section of corn drying kiln and main internal components (after Timpany et al. 2011, p.74)

Reconstructed later medieval corn drying kiln at Ferrycarrig Park (l); Experimental early medieval corn drying kiln at University College Dublin showing three main kiln components (r) (Photo: Susan Lyons)

Figure 5.5.2 Corn drying kilns in the Irish archaeological record

5.5.5 Historical evidence for corn drying kilns

Early documentary sources make frequent reference to the use of kilns (Kelly 1997, 241-242), and the *Críth Gablach* (Law of Status), which dates from c.700 AD indicates that some were part-owned by multiple owners, usually the lower ranking famers (*ócaire)* (ibid.) who were required to share their kiln, but larger farmers (*bóaire*) and the higher ranks were expected to have sole ownership. The law tracts also describe a broom, hide and flail as being part of the kiln equipment (Gailey 1970, 65, Rynne 2000a, 208) suggesting that these were well organised activities. The time required to complete the drying process was dependent on a number of factors: weather conditions (dry being favourable); the purpose the grain was intended for; the heat generated by the kiln fire; the strength of the draught and subsequent control of it; the initial moisture of the grain; its quantity; and the depth to which it was spread on the drying floor (Knox 1906, 270, Fenton 1997). The systematic use of these features accommodating multiple families would therefore have required an efficient level of management and maintenance.

The use of another's kiln without permission was punishable by payment of a milch cow (Kelly 1988, 144) and to erect a kiln on another's land was illegal (Kelly 1997, 434; *CIH* iii, 759.9-11). They are also mentioned in the ninth century *Trecheng Breth Féne* (*A Triad of Judgments of the Irish*) (Meyer 1906b, Kelly 2004, 2), where one passage prescribes against the destruction of a kiln:

Three black husbandries: thatching with stolen things, putting up a fence with a proclamation of trespass, kiln-drying with scorching

(century.http://celt.ucc.ie/published/T103006.html; Accessed July 24, 2017)

The various references to corn drying kilns in documentary sources therefore highlight the significance of these features in the medieval settlement structure and economy.

5.5.6 Chronological change in kiln wood use: A Bayesian approach

A total of 37 radiocarbon dates were used to construct the Bayesian model **(Table 5.5.2; Figure 5.5.3).** Two kilns, Baysrath Site 53/54 [Kiln 15] (UBA16088) and Milltown Site 1/2 [16] (Poz26964) were omitted from the model as they did not produce sufficient charcoal identifications for meaningful interpretation**.** The dataset was ordered into this conceptual model using the main phasing parameters as identified in the kiln charcoal dataset; ***Corylus* (Hazel) dominant; Mixed taxa dominant; *Quercus* (Oak) dominant.**

The model gave an overall agreement index of 102 which is statistically valid for interpretation **(Table 5.5.3; Figure 5.5.4).** One determination (UBA13778: AD 1148 ±20) on alder charcoal from Hughes' Lot East [Kiln 148] had a slightly lower agreement index (A = 48.7%). It remains in the model however as it does not affect the overall output. A collation of the radiocarbon dataset has provided modelled determinations for the proposed start, end and duration of these main wood use phases.

Table 5.5.2 List of radiocarbon dates for crop drying kilns

County	Site	Laboratory Code	Context no.	Context description	Sample no.	Material dated	Radiocarbon Age BP	AMS δ 13C	Calibrated Ranges 68.2% probability (1 sigma)	Calibrated Ranges 95.4% probability (2 sigma)
Tipperary	AR31 Borris/Blackcastle	UBA12877	2708	Basal fill of kiln [1758]	1172	Wheat grain	598 ±27	-21	Cal AD 1311-1398	Cal AD 1298-1408
Tipperary	AR31 Borris/Blackcastle	UBA12878	662	Basal fill of kiln [660]	419	Wheat grain	840 ±28	-15.3	Cal AD 1166-1225	Cal AD 1156-1262
Tipperary	AR31 Borris/Blackcastle	UBA12879	191	Basal fill of kiln [91]	144	Blackthorn charcoal	377 ±23	-16.9	Cal AD 1453-1616	Cal AD 1447-1629
Tipperary	AR33 Borris	UBA12498	921	Kiln B [921]	522	Barley grain	1039 ±21	-24.8	Cal AD 992–1017	Cal AD 973–1025
Tipperary	AR33 Borris	UBA12502	1148	Fill of kiln [1145]	898	Barley grain	1300 ±2	-26.3	Cal AD 669–765	Cal AD 662-771
Tipperary	AR33 Borris	UBA12504	2074	Fill of kiln [2074]	1663	Barley grain	1257±23	-26.7	Cal AD 693–774	Cal AD 673-856
Tipperary	A26 Ballydavid	UBA11078	282	Basal fill of kiln [287]	225	Barley grain	1587 ± 22	-22.3	Cal AD 428 – 533	Cal AD 422 – 537
Tipperary	AR01 Gortmakellis	UBA11639	118	Basal fill of kiln bowl [19]	412	Barley grain	1204 ± 20	-22.7	Cal AD 778-866	Cal AD 772-888
Tipperary	Monadreela Site 5	UBA13705	167	Basal fill of kiln [155]	29	Ash charcoal	1248 ± 18	-27.8	Cal AD 682-767	Cal AD 671-772
Tipperary	Monadreela Site 8	UBA13716	102	Basal fill of kiln [100]	4	Oat grain	880 ± 49	-25.4	Cal AD 1011-1289	Cal AD 1034-1252
Tipperary	Monadreela Site 11	UBA14372	45	Basal fill of kiln [38]	19	Wheat grain	1594 ± 37	-23.8	Cal AD 423-533	Cal AD 394-551
Tipperary	Boscabell Site 19	UBA13743	183	Basal fill of kiln [184]	29	Oat grain	920 ± 25	-26.9	Cal AD 1045-1157	Cal AD 1030-1172
Tipperary	Hughes' Lot East Site 25ii	UBA13763	423	Basal fill of kiln [401]	35	Cherry charcoal	1295 ± 22	-28.5	Cal AD 672-766	Cal AD 665-772
Tipperary	Hughes' Lot East Site 25ii	UBA13765	797	Basal fill of kiln [307]	147	Ash charcoal	1192 ± 24	-27.9	Cal AD 781-878	Cal AD 772-933
Tipperary	Hughes' Lot East Site 25ii	UBA13916	793	Fill of kiln [795]	152	Ash charcoal	1416 ± 25	-26	Cal AD 618-651	Cal AD 597-660
Tipperary	Hughes' Lot East Site 25iv	UBA13778	167	Fill of kiln [148]	18	Alder charcoal	1148 ± 20	-28.1	Cal AD 877-964	Cal AD 782-971
Tipperary	Hughes' Lot East Site 25iv	UBA13777	154	Fill of kiln [150]	21	Barley grain	1241 ± 23	-26.1	Cal AD 692-806	Cal AD 686-868
Carlow	Coneykeare	UBA12245	23	Fill of kiln [23]	4	Alder charcoal	1335 ± 19	-27.4	Cal AD 658-678	Cal AD 650-764
Kilkenny	Holdenstown Site 2	UBA15407	181	Fill of kiln [182]	111	Barley grain	1699 ±23	-27.1	Cal AD 264-390	Cal AD 258-409
Kilkenny	Templemartin	UBA14057	5	Fill pf kiln [3]	2	Young hazel	1669 ± 29	-27.7	Cal AD 345-415	Cal AD 259-430
Kilkenny	Knockadrina	UBA12180	528	Fill of kiln [517]	114	Barley grain	1194 ±21	-28.4	Cal AD 781–874	Cal AD 776–889
Kilkenny	Kellysgrange	UBA12182	163	Kiln [4]	8	Hazel charcoal	1381 ±24	-22.2	Cal AD 644–663	Cal AD 615–671

County	Site	Laboratory Code	Context no.	Context description	Sample no.	Material dated	Radiocarbon Age BP	AMS δ 13C	Calibrated Ranges 68.2% probability (1 sigma)	Calibrated Ranges 95.4% probability (2 sigma)
Kilkenny	Kellysgrange	UBA12183	38	Kiln [9]	21	Ash charcoal	1261 ±22	-25	Cal AD 693–772	Cal AD 673–806
Kilkenny	Kellysgrange	UBA12184	61	Kiln [43]	29	Pomoideae charcoal	1319 ±24	-25.5	Cal AD 660–762	Cal AD 654–769
Kilkenny	Kilree Site 3	UBA12205	290	Flue in kiln [395]	351	Prunus sp. charcoal	850 ± 26	-33.1	Cal AD 1169-1218	Cal AD 1058-1258
Kilkenny	Baysrath AR53/54	UBA16088	2153	Fill of kiln [15]	1140	Barley grain	1626± 32	-24.9	Cal AD 390-530	Cal AD 349-557
Kilkenny	Leggetsrath East	UBA15447	220	Fill of kiln [276]	15	Cherry/plum/ blackthorn	587± 24	-25.5	Cal AD 1317-1403	Cal AD 1303-1411
Kilkenny	Scart and Rahard	UBA13985	50	Fill of kiln bowl [45]	5	Barley grain	675 ± 30	-21.4	Cal AD 1270-1310	Cal AD 1270-1320
Kilkenny	Shankill Site 2	UBA12237	24	Fill of kiln [9]	7	Holly charcoal	775 ± 17	-24.1	Cal AD 1246-1272	Cal AD 1222-1274
Kilkenny	Scart AR20	Poz25473	1	Primary fill kiln [3]	27	Oat grain	1125 ± 30	-25.0	Cal AD 890-975	Cal AD 810-1000
Kilkenny	Scart AR20	Poz25579	3	Primary fill kiln [1]	68	Oat grain	1030 ± 35	-27.4	Cal AD 980-1030	Cal AD 890-1120
Kilkenny	Scart AR20	UBA13986	49	Fill of pit kiln [53]	24	Oat grain	826 ± 21	-31.1	Cal AD 1208-1256	Cal AD 1173-1260
Kilkenny	Coolmore	UBA14005	16	Fill of kiln chamber	10	Young oak charcoal	796 ± 19	-26.4	Cal AD 1224-1258	Cal AD 1216-1268
Kilkenny	Milltown AR01-02	Poz26964	36	Fill of kiln [16]	17	Barley grain	1495 ± 35	Not specified	Cal AD 540-610	Cal AD 430 - 650
Kilkenny	Milltown AR03	Poz26967	24	Fill of kiln chamber [81]	27	Hazelnut shell	1270 ± 35	Not specified	Cal AD 685-775	Cal AD 660-870
Kilkenny	Milltown AR04	Poz26975	76	Fill of kiln [122]	128	Barley grain	1455 ± 35	Not specified	Cal AD 665-770	Cal AD 550-660
Kilkenny	Ballykeoghan AR26	UBA13983	211	Fill of stokehole in kiln [221]	111	Oat grain	1338 ± 21	Not specified	Cal AD 657-677	Cal AD 648-765
Kilkenny	Ballykeoghan AR26	UBA13977	107	Fill of kiln [7]	48	Oat grain	896 ±24	Not specified	Cal AD 1049-1155	Cal AD 1043-1212
Kilkenny	Ballykeoghan AR26	UBA13980	150	Fill of kiln [149]	73	Oat grain	1248±31	Not specified	Cal AD 688-802	Cal AD 679-869

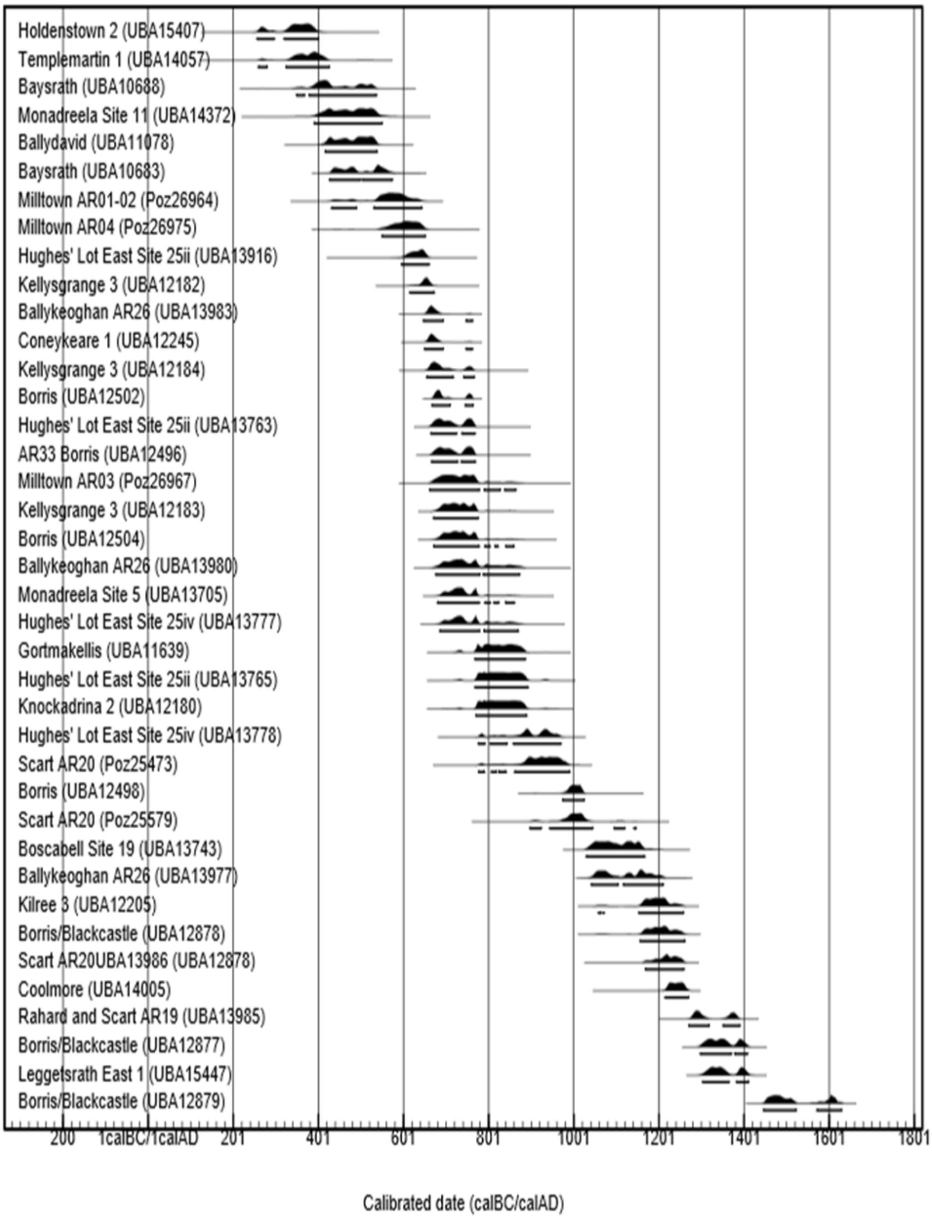


Figure 5.5.3 Calibration graph (OxCal) of radiocarbon dates from corn drying kilns in this study

Table 5.5.3 Modelled posterior dates for corn drying by taxa dominant

Corn drying kiln wood by taxa dominant	Modelled (AD) 68%			Modelled (AD) 95%			Model index	Index Agreement (A'c= 60.0%)
	from	to	%	from	to	%		
Kiln Wood Use 1								
Start Hazel Dominant	313	421		158	...	95.4		0.5
Hazel Dominant								
Holdenstown [182]	360	418	68.2	327	426	95.4	75.8	1.3
Templemartin [3]	378	420	68.2	340	426	95.4	101.7	6
Monadreela [38]	392	452	68.2	390	529	95.4	89.2	3.2
Ballydavid	400	463	68.2	393	525	95.4	70.7	1.2
=First Hazel Dominant	313	421	68.2	158	...	95.4		0.5
=Last Hazel Dominant	394	524	68.2	391	681	95.4		0.5
=Duration Hazel Dominant	0	234	68.2	0	502	95.4		16.2
End Hazel Dominant	394	524	68.2	391	681	95.4		0.5
Kiln Wood Use 2								
Start Mix Wood Dominant	528	580	68.2	494	602	95.4		98.3
Mix Wood Dominant								
Baysrath [4]	542	595	68.2	531	606	95.4	61.8	98.9
Milltown [122]	590	641	68.2	561	652	95.4	105.2	99.8
Hughes Lot East [795]	618	651	68.2	596	660	95.4	99.9	99.7
Kellysgrange [4]	641	664	68.2	616	673	95.4	97.7	99.5
Ballykeoghan [221]	656	680	68.2	647	763	95.4	98.6	99.6
Coneykeare	658	678	68.2	650	762	95.4	99.2	99.8
Kellysgrange [43]	660	760	68.2	655	767	95.4	99.3	99.7
Twomileborris AR33 [1145]	672	760	68.2	667	764	95.4	97.8	99.8
Hughes Lot East [401]	672	764	68.2	665	769	95.4	99.2	99.6
Milltown [81]	685	768	68.2	662	820	95.4	103.7	99.7
Kellysgrange [9]	692	768	68.2	675	775	95.4	100.9	99.5
Twomileborris AR33 [2074]	694	770	68.2	674	799	95.4	102.2	99.7
Ballykeoghan [149]	690	774	68.2	673	849	95.4	106.6	99.7
Monadreela [155]	709	772	68.2	680	821	95.4	101.7	99.5
Hughes Lot East [150]	695	776	68.2	682	853	95.4	106.1	99.7
Gortmakellis [19]	770	828	68.2	725	872	95.4	97.7	99.6
Knockadrina [517]	772	824	68.2	730	874	95.4	99.6	99.6
Hughes Lot East [308]	772	826	68.2	727	877	95.4	100	99.5
Hughes Lot East [148] (Poor agreement = 48.7%)	776	794	68.2	772	896	95.4	48.7	99.4
=First Mix Wood Dominant	528	580	68.2	494	602	95.4		98.3
=Last Mix Wood Dominant	798	875	68.2	784	919	95.4		96.7
=Duration Mix Wood Dominant	238	338	68.2	202	401	95.4		96.7
End Mix Wood Dominant	798	875	68.2	784	919	95.4		96.7
Kiln Wood Use 3								
Start Oak Dominant	890	972	68.2	800	993	95.4		95.2
Oak Dominant								
Scart [3]	936	986	68.2	890	996	95.4	99.5	98.5
Twomileborris AR33 [920]	992	1017	68.2	975	1025	95.4	99.8	99.3

Scart [1]	986	1026	68.2	906	1147	95.4	103.7	99.3
Boscabell [184]	1045	1156	68.2	1030	1168	95.4	99.5	99.4
Ballykeoghan [7]	1048	1184	68.2	1042	1212	95.4	99	98.9
Monadreela [100]	1048	1218	68.2	1035	1249	95.4	99.7	98.1
Kilree [395]	1048	1218	68.2	1059	1258	95.4	99.9	99
Twomileborris AR31 [660]	1166	1240	68.2	1156	1262	95.4	99.7	99.5
Scart [53]	1205	1254	68.2	1170	1259	95.4	99.7	99.4
Coolmore [7]	1225	1258	68.2	1215	1270	95.4	99	99.5
Shankill [9]	1246	1272	68.2	1222	1274	95.4	98.8	99.3
Scart/Rahard [95]	1279	1383	68.2	1271	1391	95.4	98.6	99.5
Twomileborris AR31 [1758]	1310	1399	68.2	1299	1409	95.4	99.4	99.4
Leggetsrath [276]	1316	1403	68.2	1303	1412	95.4	99.2	99.6
Twomileborris AR31 [91]	1450	1485	68.2	1444	1515	95.4	111.1	99.5
Last Oak Dominant	1458	1526	68.2	1448	1622	95.4		95.5

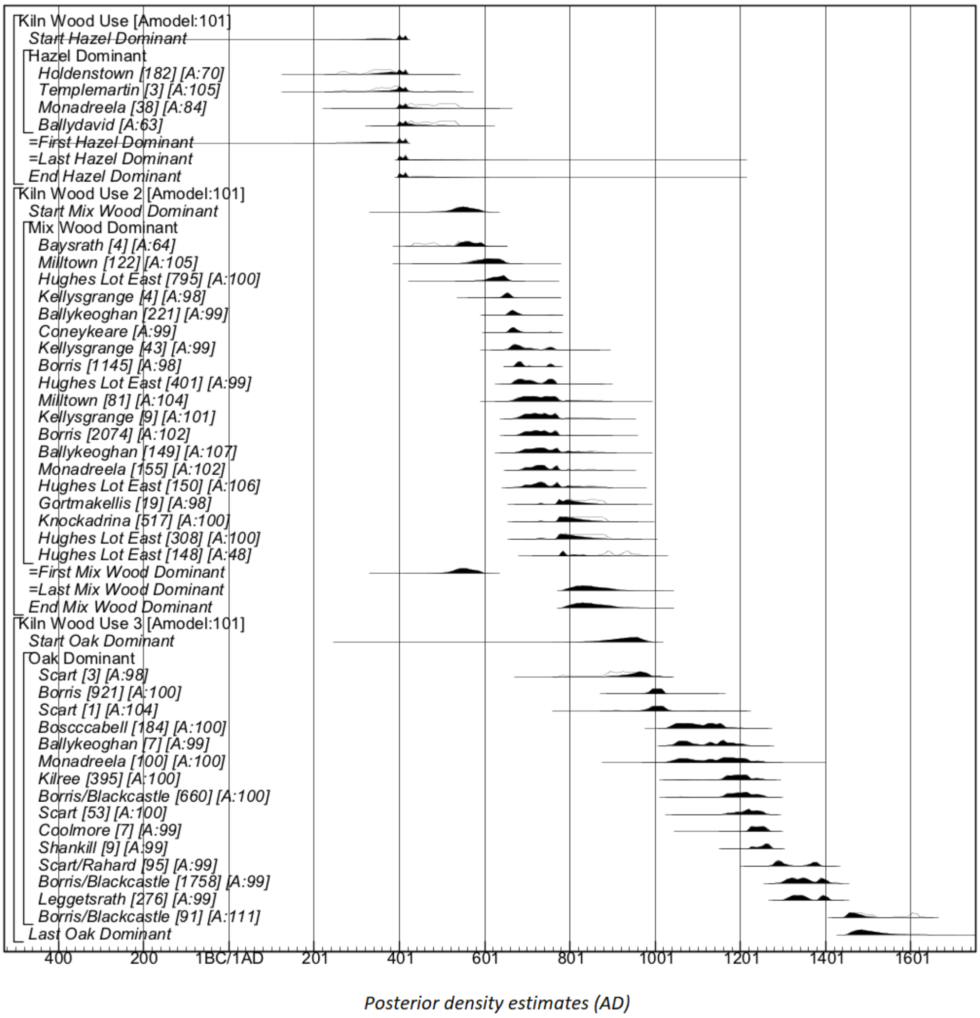


Figure 5.5.4 Probability distribution of dates from corn drying kilns by taxa dominant

To aid in the discussion of when the main phases of medieval wood use, as categorised through the charcoal assemblages recorded from corn drying kilns, was likely to have occurred, the key periods of interest are the estimated posteriors for the end of the hazel dominant phase, the start and end of the mixed taxa phase and the commencement of the oak dominant phase of wood use **(Figure 5.5.5).**

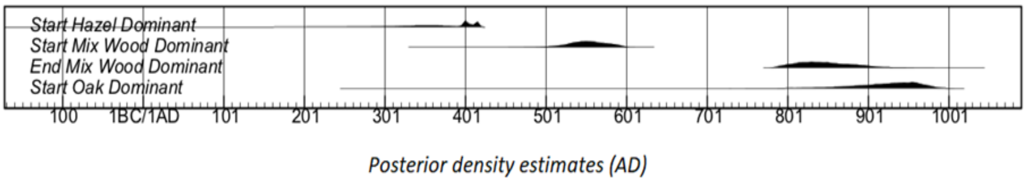


Figure 5.5.5 Probability distribution of dates for the main boundaries of wood use from corn drying kilns

The earliest corn drying kiln activity identified from this study, dating to c. fifth century AD or just before it, was defined by a hazel dominant charcoal assemblage. These included the kilns at Holdenstown and Templemartin in Kilkenny and Ballydavid and Monadreela (Site 11), in Tipperary. To determine when this dominant hazel phase was likely to have ended, which coincides with the beginnings of the early medieval period, the model generated a posterior date of between *313-421 AD (68% probability)* or *391–681 AD (95% probability)* **(Figure 5.5.6).**

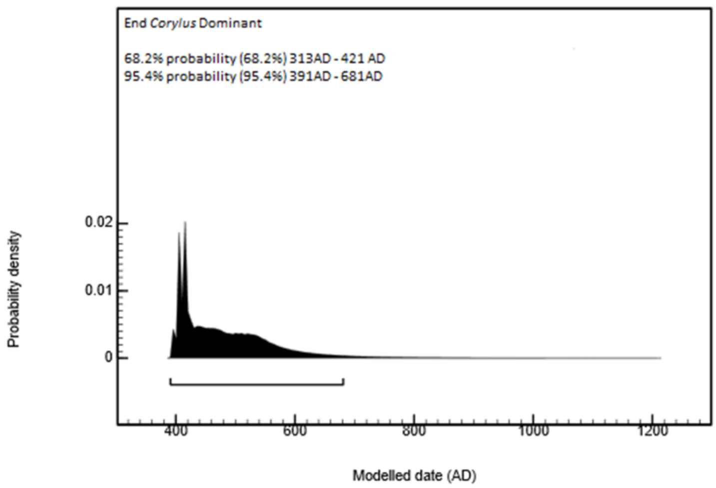


Figure 5.5.6 Modelled end date for a *Corylus* (hazel) dominant phase from corn drying kilns

The use of a more diverse mix of wood taxa defined by the rise in ash, Maloideae and *Prunus* wood species, dispersed with fluctuating oak charcoal abundances was confined to kilns dating from the sixth century AD. This pattern was evident at a number of sites such as Ballykeoghan, Baysrath, Coneykeare, Kellysgrange, Knockadrina and Milltown, in Kilkenny and Borris, Gortmakellis, Hughes' Lot East and Monadreela (Site 5) in Tipperary. The model has estimated that the rise in a use of mixed wood taxa from kilns is likely to have commenced between *528-580 AD (68% probability)* or *494–602 AD (95% probability)* **(Figure 5.5.7).**

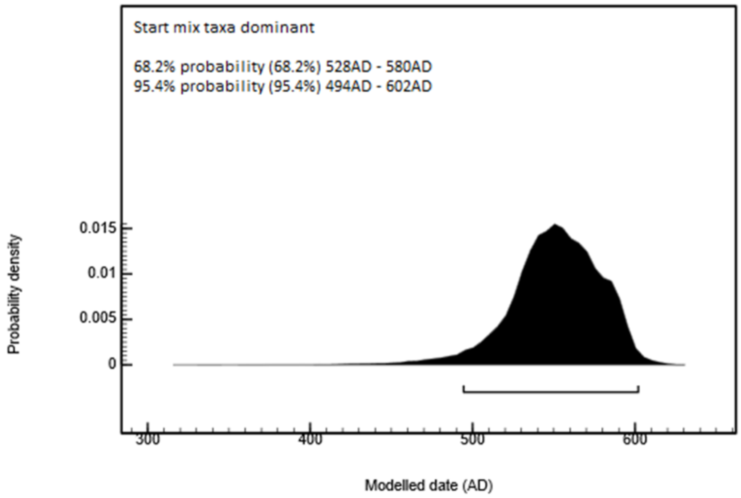


Figure 5.5.7 Modelled start date for a mixed taxa phase from corn drying kilns

Based on the modelled dates for this phase, the duration of when this mixed wood use of activity is predicted to have lasted is between *238 – 338 years* (*68.2% probability)* or *202 – 400 years (95.4% probability)* **(Figure 5.5.8).**

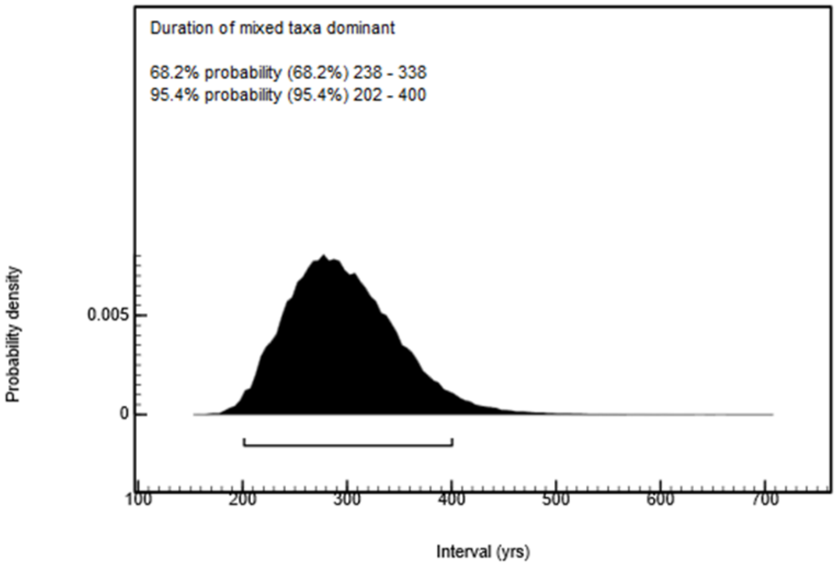


Figure 5.5.8 Probability of duration for a mixed taxa phase from corn drying kilns

The end of the mixed wood phase of kiln activity is estimated as ending between *798-875 AD (68% probability)* or *784–919 AD (95% probability)* **(Figure 5.5.9).**

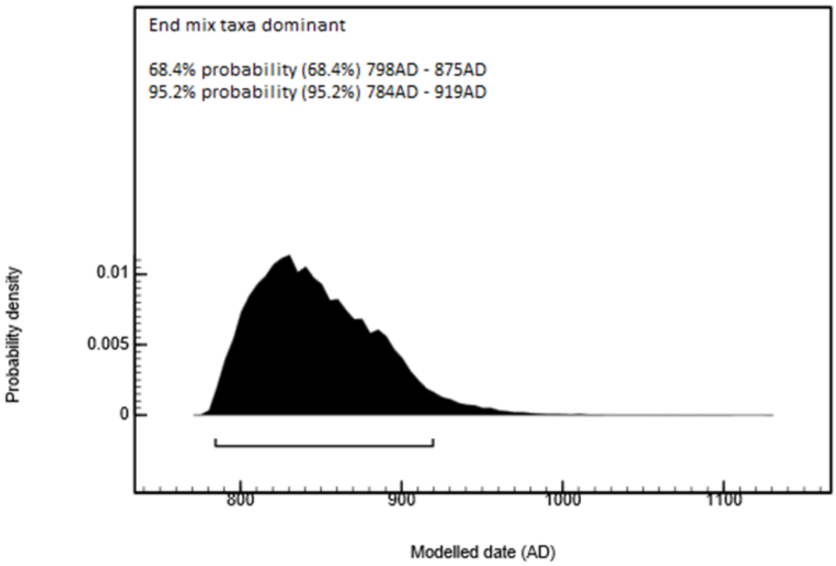


Figure 5.5.9 Modelled end date for a mixed taxa phase from corn drying kilns

Superseding this phase, oak became the dominant wood identified in corn drying kilns dating from the c. tenth century AD according to the PFA and statistical results. This change in wood use was also defined by a notable decrease in ash and the invariable use of fruitwood species (Maloideae and *Prunus*), a pattern which was recorded from Coolmore, Kilree, Leggetsrath, Scart and Scart/Rahard in Kilkenny and Boscabell, Borris/Blackcastle and Monadreela (Site 8) in Tipperary. The start of this phase is estimated as beginning between *890-972 AD (68% probability)* or *800–993 AD (95% probability)* **(Figure 5.5.10).**

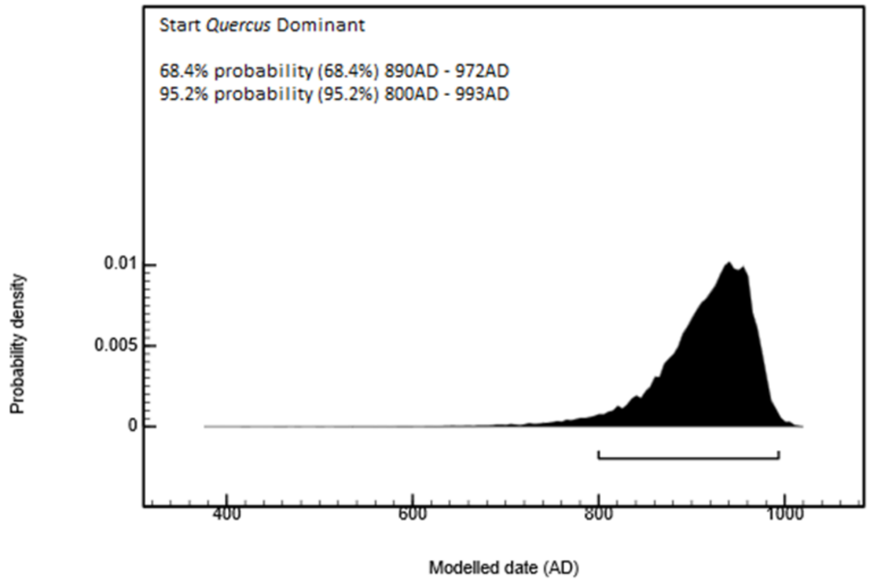


Figure 5.5.10 Modelled start date for a *Quercus* (oak) dominant phase from corn drying kilns

Overview of results

The use of Bayesian modelling in the context of the corn drying kilns is a new approach to understanding the chronology of these features and the activity associated with them. The main premise for implementing this technique was to constrain the chronological sequences for these features to provide higher resolution dating parameters to establish when major changes in wood use were likely to have occurred. With three main horizons in wood use/change established through the kiln dataset, the Bayesian model has generated a workable set of posterior dates to allow for a more robust interrogation of when wood resource changes are likely to have occurred during the medieval period. This will help to clarify and interpret the reasons behind these fluctuating wood dynamics, which, in turn will provide a new approach to dating major shifts recorded in the archaeological and historical record.

5.5.7 Comparing wood taxa to cereal grain assemblages

The majority of the corn drying kilns from this study contained a high frequency of carbonised cereal grains recovered from the same stratigraphical context as the charcoal remains identified. Kilns where a dominant crop type (>100 grains) was identified were selected to investigate if any correlation or patterns of use existed with the wood data results from the same feature. A total of 43 kilns with a combined charcoal count of 3954 were arranged into a normal response matrix**.**

To qualify the abundance and variance within the dataset, raw charcoal counts were converted to percentage frequencies, which gave a better representation to less frequent taxa. A corresponding explanatory matrix containing a coding variable to denote the dominant crop **(1 = Oat; 2 = Barley; 3 = Wheat)** was created. The dataset was run through NMS which produced a final stress of between **7.50** and **14.16** and a ***p*-value of <0.05.** In addition, the results were also run through MRPP to identify patterns between and within the main group pairings.

The main observations from the NMS ordination scores show that hazel was more clustered towards wheat, Maloideae, *Prunus* wood group and ash were all more closely correlated to barley, with oak clustering more towards an oat dominated crop assemblage **(Figure 5.5.11).** This trend is further supported by Indicator Species Analysis, which shows that ash, willow and the Maloideae wood group are strongly associated with a dominant barley assemblage; hazel is an indicator species of wheat assemblages, with oak is more closely associated with a dominant oat crop. **(Table 5.5.4).**

Table 5.5.4 Indicator Species Analysis of wood taxa from corn drying kilns containing a dominant crop

Taxon	Dominant cereal	Indicator Value (IV)
Maloideae	Barley	**32.7**
Salix	Barley	**26.7**
Quercus	Oat	**46.4**
Fraxinus excelsior	Barley	**52.1**
Corylus avellana	Wheat	**39.1**
Prunus spinosa	Wheat	19.2
Prunus avium	Barley	23.5
Prunus types	Wheat	13.6

Seed = 4357 **p = 0.008**

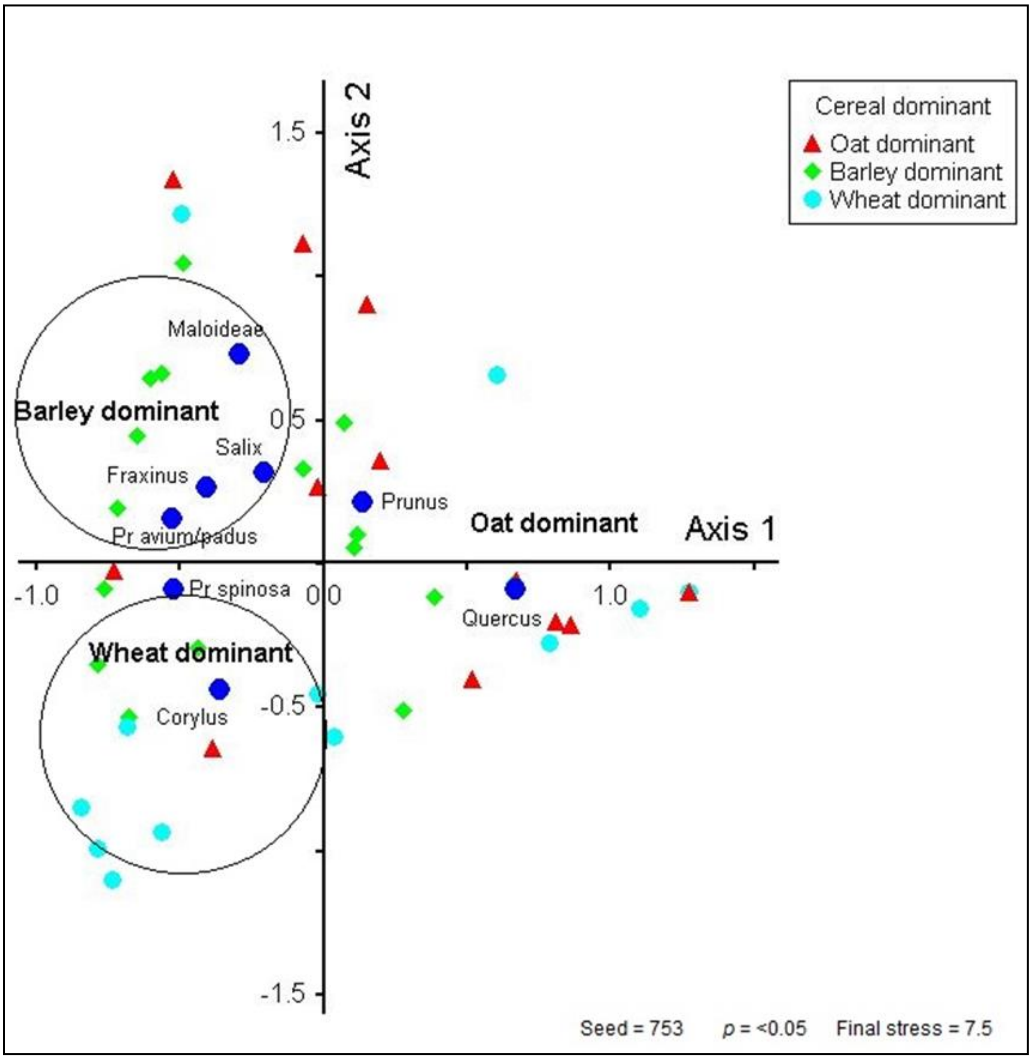


Figure 5.5.11 NMS Axis 1v2 ordination of combined charcoal samples from corn drying kilns showing dominant crops

Attention is drawn to the inverted linear relationship between Maloideae, *Prunus* wood species and ash (positive upper Axis 2) and hazel (negative lower Axis 2). This pattern shows increases in Maloideae wood species happen at the same time as hazel is declining, suggesting that when Maloideae woods are being used in kilns, hazel is not and vice versa. This is similar to the ordination results comparing wood taxa by period type **(Chapter 4; 4.3.3)** and particularly the dichotomy between hazel and Maloideae wood species, a sequence that is now augmented when comparing wood taxa to cereal crops.

In **Table 5.5.5,** oak has a strong positive correlation with Axis 1 compared to negative values for most of the other taxa. When oak is being used, many other species are not and vice versa. This further supports previous results, demonstrating that when oak is used in kilns, it supersedes the use of all other taxa collectively. The associated scatterplot depicting the abundance of oak from each kiln shows that while ash, hazel and blackthorn have similar values to each other and are positively correlated in Axis 1 and Axis 2. This order suggests that hazel and blackthorn are most probably being used together, but not at the same time as oak. This supports the results illustrated in the ordination graph, which shows that oak is strongly correlated to an oat dominant assemblage and does not co-occur with hazel or blackthorn, which is strongly correlated with kilns containing a dominant wheat crop.

Hazel has a strong negative correlation in Axis 2, compared to a strong positive correlation with the Maloideae wood group, indicating that when hazel is being used, Maloideae woods are not. The dichotomy between hazel and Maloideae indicates that hazel is not being used when Maloideae is and vice versa. This further supports the results from the ordination of wood species by phase and Indicator Species Analysis, where hazel is associated more with wheat and Maloideae with barley dominant crop assemblages.

Table 5.5.5 Correlations (Pearson's *r*-value) of explanatory variables with NMS-generated axes for combined samples from corn drying kilns (values in red are statistically significant at p<0.05 level for two-tailed t-test)

Taxon	Axis 1 *r-value*	Axis 2 *r-value*	Axis 3 *r-value*
Fraxinus excelsior	-0.341	0.249	-0.796
Salix	-0.149	0.256	0.049
Prunus spinosa	-0.471	-0.084	0.178
Corylus avellana	-0.561	**-0.781**	0.14
Prunus avium/padus	-0.171	0.057	0.213
Prunus type	0.071	0.135	0.358
Quercus	**0.965**	-0.152	0.055
Maloideae	-0.284	**0.804**	0.456

When the results are run through MRPP to identify differences between the wood species and a dominant crop, there is a notable difference between the groups (T = -4.093, P = 0.0022, A = 0.066). This suggests that there is some dissimilarity between barley, oat and wheat groupings (negative T; low P) but that variation of wood taxa within the sample units are less heterogeneous that expected (higher A value). When the pairwise comparison values are interpreted **(Table 5.5.6),** which compares each group to each other, there is a more obvious difference between the barley versus oat and wheat, as indicated by the low T and P value (T = -3.338; P = 0.009; T = -3.354; P = 0.005). The high A values (0.0514; 0.0537) show that the sample units are more similar than expected, indicating that the woods found with barley are also found with oat and wheat.

In contrast, values for oat versus wheat are more similar (T= - 1.994), meaning that there is more similarity between the woods found with oat and wheat assemblages. The A value however (0.0477) also indicates that the within sample units are more similar to each other than expected. This would explain that while oak is found proportionally higher with oat and hazel with wheat, these taxa are more likely found with both wheat and oat but not with barley. This test highlights that there is a greater difference in the woods used with barley than with oat and wheat, which supports the previous tests, showing Maloideae to be strongly correlated with barley and not with oat or wheat. This may explain why the Maloideae wood group is not being used at the same time or in the same way as other taxa (hazel, oak, blackthorn). This trend suggests that there is a distinct separation of use as to when or how Maloideae woods are treated with respect to corn drying kilns, while statistically hazel and oak are found more closely together.

Table 5.5.6 Pairwise Comparison (MRPP) for kilns by dominant crop type (significant values in red)

Dominant crop	Test	Barley	Wheat
Oat	T	**-3.338**	-1.994
	P	**0.009**	0.0488
	A	**0.0514**	0.0477
Wheat	T	**-3.594**	
	P	**0.005**	
	A	**0.0537**	

Overall **T = -4.093** **P = 0.0022** **A = 0.066**

5.5.8 Early medieval kilns v Later medieval kilns

To demonstrate if there were any differences between pre-tenth century AD and post tenth century AD kilns the values for each dataset were compared. This was to see if the trends highlighted in the previous section were more correlated to early or later kiln activity. From pre-tenth century AD corn drying kilns, the main observations from the ordination scores show that hazel is more closely correlated with wheat, the Maloideae, *Prunus* wood group and ash are all more closely correlated to barley, with oak strongly correlated to oat **(Figure 5.5.12).**

In **Table 5.5.7** below, hazel values show a high positive correlation with Axis 1 while Maloideae is strongly negative on Axis 1. This order suggests that hazel and Maloideae woods are both significant species used in pre-tenth century kilns, but are not in use at the same time. This therefore supports the results illustrated through ordination from the overall kiln data above, where hazel, when it occurs is mostly found with wheat. On Axis 2, a strong positive oak value is found with a strong negative hazel value, so when oak is being used in kilns hazel is not and vice versa. Ash values are strongly positive on Axis 3. This can be interpreted as oak being used in kilns when ash and hazel are not, possibly at the same time as Maloideae, but not in the same kilns as the latter. Similarly, ash and hazel seem to be used at the same time but not together, while hazel and Maloideae woods are not found together at the same time. This contrast between when hazel and Maloideae woods are being used is a strong feature of the kiln datasets supported up by multiple statistical methods and demonstrates that a clear shift in wood use is at play when it comes to corn drying activities.

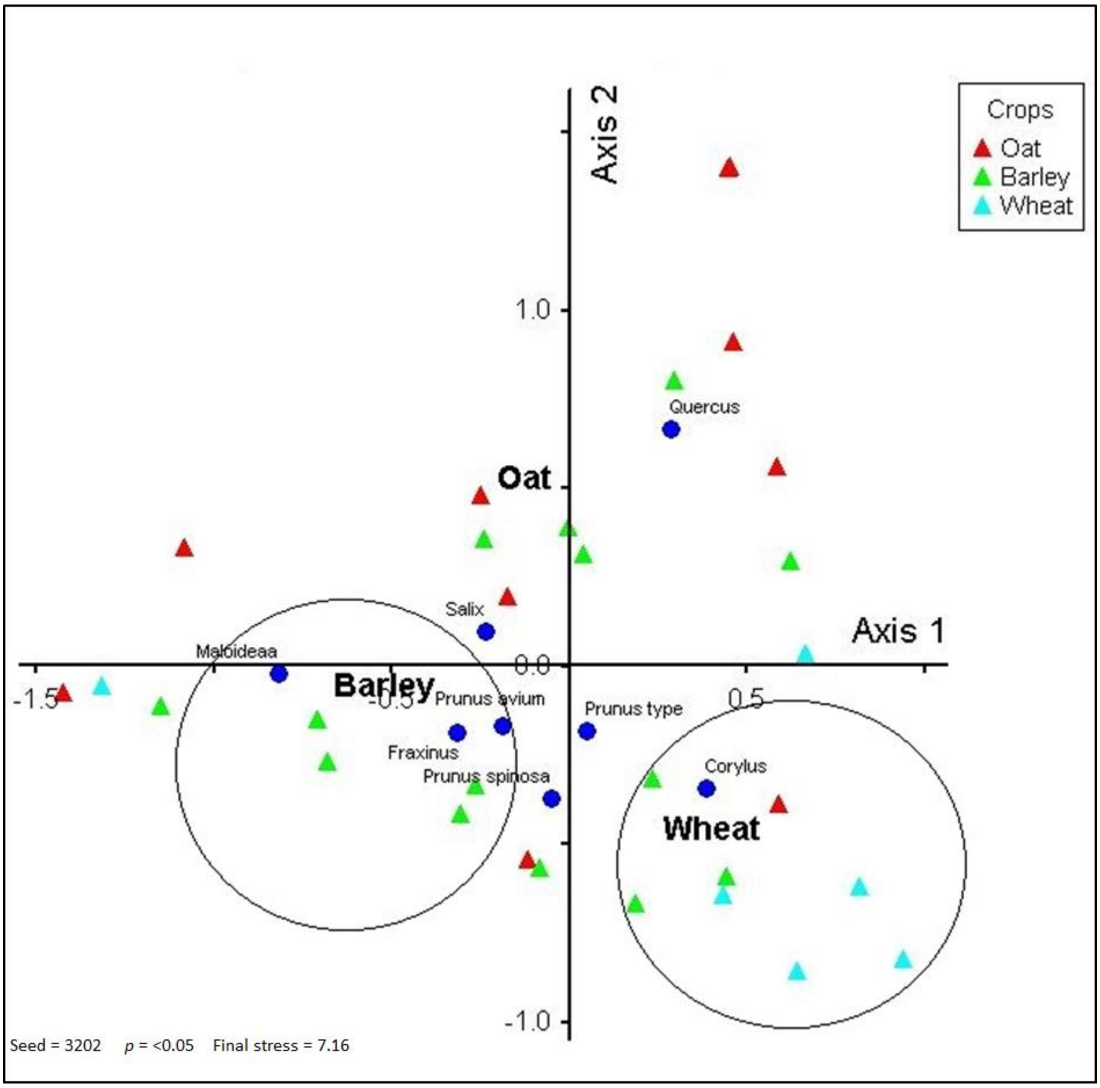


Figure 5.5.12 NMS Axis 1v2 ordination of samples from early medieval corn drying kilns (5th – 9/10th cen. AD)

Table 5.5.7 Correlations (Pearson's *r*-value) of explanatory variables with NMS-generated axes for combined samples from early medieval corn drying kilns (values in red are statistically significant at p<0.05 level for two-tailed t-test)

Wood taxa	Axis 1 *r-value*	Axis 2 *r-value*	Axis 3 *r-value*
Fraxinus excelsior	-0.308	0.189	0.892
Salix	-0.167	-0.075	-0.137
Prunus spinosa	-0.057	0.387	0.184
Corylus avellana	**0.685**	**-0.673**	-0.183
Prunus avium	-0.077	0.068	-0.271
Prunus type	0.041	0.186	-0.055
Quercus	0.388	**0.909**	0.01
Maloideae	**-0.874**	0.011	-0.411

This trend is further supported by ISA, which shows that ash and *Prunus* strongly associated with a dominant barley assemblage; hazel is an indicator species of wheat assemblage, with oak most closely associated with a dominant oat crop **(Table 5.5.8).** This test however shows blackthorn to be a strong indicator species from kilns where wheat is dominant in pre-ninth century AD kilns, while values for the Maloideae wood group are stronger with oat than barley in this phase. This is in contrast to the ISA test for all kilns, where the Maloideae woods are indicators of a dominant barley crop.

The close association between blackthorn, hazel and ash has been highlighted in a previous discussion, where it's been argued that all three wood taxa are being used at the same time, but in different ways and not always with each other. Since hazel charcoal has been shown to be closely related to wheat, perhaps the high blackthorn values from earlier kilns reflects this relationship between hazel and blackthorn, while used at the same site, not at the same time.

Table 5.5.8 Indicator Species Analysis of wood taxa from early medieval (5th-10th cen. AD) corn drying kilns containing a dominant crop

Taxon	Dominant cereal	Indicator Value
Maloideae	Oat	24.8
Salix	Oat	21.7
Quercus	Oat	**56.6**
Fraxinus excelsior	Barley	**53.7**
Corylus avellana	Wheat	**48.5**
Prunus spinosa	Wheat	**37.1**
Prunus avium	Barley	**28.6**
Prunus types	Barley	12.6
Seed run: 4122	***p*-value = 0.0094**	**No. of kilns: 30**

When the results are run through MRPP to identify differences between the wood species and a dominant crop from early kilns, there is a notable difference between the groups (T = -3.674, P = 0.003, A = 0.08)**.** This suggests that there is some dissimilarity between all three crops (negative T; low P) and that variation of wood taxa within the sample units are less heterogeneous that expected (high A value). When the pairwise comparison values are interpreted **(Table 5.5.9),** there is a more obvious difference between the oat versus wheat and barley versus wheat, as indicated by the low T and P values (T = -3.188; P = 0.01; T = -3.422; P = 0.006 respectively).

Oat and barley are more similar however than wheat is to oat or barley during this earlier phase. The A values (0.02; 0.077) show that wood species used with oat are slightly less similar than expected (A: 0.02) compared to the wood species used with barley (A: 0.077). This would support the Indicator Species test above, where the pattern of using oak with oat remains a constant within kilns, but the use of Maloideae woods with oat is something slightly unexpected. The higher A value for wheat (A: 0.12) indicates that within sample differences are more similar than expected, supporting the presence of blackthorn with wheat during the early period, a trend that was not obvious in the percentage frequency analysis.

This test highlights that while there is a greater difference in the woods used with barley, oat and wheat during the earlier medieval period, the woods found with an oat dominant crop also include more significant Maloideae woods and wheat more blackthorn than previously expected, while hazel remains a pattern found with wheat during this phase.

Table 5.5.9 Pairwise Comparison (MRPP) for pre-10th cen. AD kilns by dominant crop type (significant values in red)

Dominant crop	Test	Barley	Wheat
	T	-1.2687	**-3.188**
Oat	P	0.108	**0.0103**
	A	0.0238	**0.1216**
	T		**-3.422**
Barley	P		**0.006**
	A		**0.077**
Overall	**T = -3.674**	**P = 0.003**	**A = 0.08**

In post-tenth century kilns, Indicator Species Analysis **(Table 5.5.10)** continues to show oak found in oat dominated assemblages, with a more variance in wood species (ash, hazel, blackthorn and cherry) indicators of barley dominated assemblages. Kilns containing wheat are altogether much lower from post-tenth century AD kilns in this study and are therefore under-represented in this test.

Table 5.5.10 Indicator Species Analysis of wood taxa from post-10th century AD corn drying kilns containing a dominant crop

Taxon	Dominant cereal	Indicator Value (IV)
Maloideae	Barley	**59.2**
Salix	Barley	**64.2**
Quercus	Oat	**47.0**
Fraxinus excelsior	Barley	**42.3**
Corylus avellana	Barley	**39.8**
Prunus spinosa	Barley	13.5
Prunus avium	Barley	**25.0**
Prunus types	Wheat	12.1
Seed run: 2835	***p*- value = 0.08**	**No. of kilns: 14**

MRPP for post-tenth century kilns reveals very little difference between the three crops overall (T = -1.568, P = 0.075, A = 0.08) **(Table 5.5.11).** This indicates that while there is little variation in the overall wood taxa used to dry each crop in the later period the taxa used with oat contained a higher diversity than expected despite oat being dominant. Similarly, wood taxa found with a barley dominant crop is more varied, as depicted in **Table 5.5.10,** which shows a mix of ash, hazel, blackthorn and cherry. Oat and wheat are still most similar, while negative T values for barley demonstrate that the woods used in kilns where barley is dominant is still less similar than oat and wheat, but only marginal.

Table 5.5.11 Pairwise Comparison (MRPP) for post-10th cen. AD kilns by dominant crop type (significant values in red)

Dominant crop	Test	Barley	Oat
	T	**-1.966**	0.411
Wheat	P	0.049	0.575
	A	**0.1**	-0.021
	T		**-1.807**
Barley	P		0.059
	A		**0.13**
Overall	**T = -1.568**	**P = 0.075**	**A = 0.08**

Comparing this to the results of wood variance from pre-tenth century AD corn drying kilns, there is less of a distinction between the taxa used to dry oat, wheat and barley in later post-tenth century kilns. Variance in wood use fluctuates and the patterns noted for earlier kilns are not so apparent**.** The opposing use of when hazel and Maloideae is being found for example is much more obvious in earlier dated kilns and there is less correlation between the woods used with oat and wheat that those found with a barley crop.

5.5.9 Overview of results

The statistical analysis helps to amplify the trend noted in **Chapter 4 (4.3.4)** where a more diverse wood composition is found in pre-tenth century AD kilns compared to post-tenth century kilns. The rise in fruitwood species (Maloideae wood group *Prunus* sp.) from the earlier to later kilns is also a pattern emerging from the statistics, together with a move to a dominant single species (oak) in later kilns. Comparing the wood from corn drying kilns, through the charcoal data, with associated dominant crops from the same kiln contexts have also revealed some interesting results concerning how wood species were used in kilns, which provides insights into the factors that influenced their selectivity and the possibility of seasonal wood use at a site.

6 Synthesis and Discussion

6.1 Introduction

The salient trends being recognised in the charcoal record analysed from this thesis include:

- the variance in wood taxa being used between the early and late medieval period
- the role of oak during this time, particularly its sporadicity between the late seventh and late ninth/tenth century AD and the wood resource strategies that were employed as a response to this oak variability
- the subsequent rise in oak use from the tenth/eleventh century and into the later medieval period at the same time wood resource use becomes less diverse

These findings provide insights into wood selection regimes for specific activities and context-related variation within and between sites. In an attempt to estimate when prominent patterns of wood change may have occurred the use of Bayesian chronological modelling has helped to refine and redefine site chronologies and sequences of activity to interpret the charcoal record more rigorously. A series of case studies were subsequently used to further illustrate the results and exemplify the continuity of wood resource use substantiated by the charcoal analyses from a suite of features that comprise rural medieval settlements. This was undertaken to establish if the use of wood at local level reflected the macro picture of fluctuating wood patterns and variance being observed through the charcoal record.

A significant outcome from the charcoal analysis is the importance of corn drying kilns as indicators of on-site wood resource use and seasonal activity, which was further enhanced by the combined analysis of the charcoal and plant macrofossil record. These distinct features, which are a quintessential component of medieval settlements, are shown to be intimately connected to how and when wood resources were utilised on a specific site and reflect discreet changes in how wood taxa were used. This provides a greater insight into the mechanisms of medieval wood management, control and distribution and as a consequence, it may be agreed that they be used as a proxy for understanding and interpreting medieval wood use at a local level. This chapter will now deliberate these results in context, in line with known historical, archaeological and palaeoenvironmental data, with a view to highlighting the valuable contribution of charcoal analysis to understanding the changing dynamics of woodland and wood resource use in medieval Ireland.

6.2 A model for wood resource use and change in medieval Ireland

Through a rigorous quantitative and statistical approach, the charcoal datasets analysed as part of this thesis have demonstrated that changes in wood resource use during the course of the medieval period (c.500-1550AD) can be recorded at local level, using the main features that define medieval settlements. When evaluated collectively, charcoal remains from structural deposits, ditches, pits and corn drying kilns particularly, all reflect not just the broad changes in wood use being discussed throughout this study, but intimate shifts in how and when specific wood taxa were being utilised at site level. This has not only provided insights into the inner workings of an individual site or feature, but potentially the socio-economic factors that may have influenced the presence of certain wood species on site and if this determined its functionality or social ranking in the medieval context.

The charcoal analysis from the corn drying kiln case study has been a significant result in the context of this thesis. Primarily, it represents the most detailed study of wood taxa that has been undertaken from medieval corn drying kilns in Ireland and indeed is unparalleled when compared to other countries, in particular Britain, where analysis is on a site by site basis for the most part (Lisa Lodwick pers comm.). One of the few published sites is the early medieval ecclesiastical site at Hoddom, Dumfriesshire, in the south west of Scotland, where 2200 charcoal fragments were analysed from a number of corn drying kiln deposits (Crone 2002). The results from this thesis have therefore revealed a number of key outcomes that are proving to be a valuable contribution to understanding wood resource use at a local and regional level during the course of the medieval period in an Irish context.

One of the main observations is that corn drying kilns closely mirrors the variance in wood resource use and change from the early to the later medieval period being recognised throughout this thesis. Through these features, a diverse wood composition interspersed with a fluctuating use of oak and ash is the pattern emerging from pre-tenth century AD activity. The rise in fruitwood species (Maloideae and *Prunus* species.) from the earlier to later kilns is also a pattern emerging from the data, together with a move to a dominant single species (e.g. oak) from post-tenth century AD and later medieval kilns. Ethnographical studies in fuel management strategies from South American communities have shown that fuel materials, including wood taxa, is more varied at times when there is a relative scarcity of suitable fuel supplies (Skar et al. 1982, 70, Johannessen and Hastorf 1990). In contrast, where or when wood is relatively abundant, only the preferred woods will be selected to be used (Skar et al. 1982). This model therefore reflects the picture presented through the kiln results, where mixed wood use could represent some degree of wood scarcity or variability in what was available for fuel, to a dominant oak, which as demonstrated, reflects its relative abundance through distribution of this resource to a site at certain times.

Using a combination of statistical tools and Bayesian chronological modelling, corn drying kilns are providing new information on wood variance during this period. They are offering new insights into when oak and ash/mixed taxa were being used, in addition to highlighting periods of seasonal on-site activities, something that few strand of archaeological evidence have achieved to date (Murray et al. 2012). As presented in Chapter 4 **(Section 4.3.4),** corn drying kilns are proving to have a close symbiotic relationship with the various activities being undertaken on a site, reflecting not just variability in wood taxa, but acting as an proxy to how and when certain wood species were being utilised. In turn, this not only highlights the shifting priorities at a site over time, but defines the human response to changes in the physical landscape, a factor perhaps brought about by pressure on resource supply through socio-economic influences as a result of the shifting cultural and political vagaries and oscillating climatic change during this period.

Corn drying kilns should therefore be considered as a predictive model for how local wood resources were used more broadly at a site and any changes that may have occurred particularly up to the late ninth/tenth century AD. The following sections will now discuss wood use and woodland change using the kiln charcoal dataset as a framework to model chronological change and wood variance during the medieval period in Ireland.

6.3 Chronological changes in medieval wood use

6.3.1 Late Iron Age to Early Medieval Period (4th- 6th century AD)

Evidence from the earliest dated kilns (fourth to fifth century AD) in this study, such as those at Baysrath, Holdenstown and Templemartin, Co. Kilkenny and Ballydavid, Co. Tipperary highlights the use of hazel as a prominent wood taxon, with a pronounced shift to using a mixed wood composition, defined by a rise in ash and /or oak and fruitwood species (Maloideae spp. and *Prunus* sp.), estimated at occurring between *494–602 AD (95% probability)* **(see Chapter 5; 5.5.6).** If this posterior date of a changing wood dynamic is accepted as a response to changes in human behaviour, then it is an extremely significant outcome, as it concurs with the earliest proposed dates for rath or ringfort construction in early medieval Ireland, c.600 AD (Lynn et al. 1981, 65, Stout 1997, 24, O’Sullivan et al. 2013, 48). This change in wood use behaviour coincides with a new settlement pattern emerging and could represent the human response to a changing landscape, and the earliest probable date range for when this transformation is likely to have happened.

The rise in ash and Maloideae species at this time in kilns is of particular interest. The occurrence of such species is considered to be representative of clearance and an emergence of secondary woodland in pollen diagrams as it is a relatively light demanding species which benefits when the woodland canopy is cleared (Caseldine and Hatton 1996, 18). It has long been recognised that there was an increase in arable farming in the first centuries AD, most notably from the third century onwards, and that this led to large-scale deforestation (Edwards 1996, 52, Mitchell and Ryan 1997, 246, Laing 2006, 65). This is also highlighted in pollen evidence, where after a hiatus in human activity stimulated a period of woodland regeneration, coined the ‘Iron Age Lull’ (Mitchell and Ryan 1997, Newman et al. 2007, Overland and O'Connell 2008), forest clearance and agricultural expansion took place during the fourth century AD (Cole and Mitchell 2003, Hall 2000, Hall 2006).

Ash values depicted in pollen records from the Irish midlands, such as Derryville, Co. Tipperary (Caseldine et al, 2005, 135), Mongan Bog, Co. Offaly (Hall and Marquoy, 2005, 1090), Ballinderry Lough, Co. Westmeath, Kilcurly, Co. Offaly (O Carroll, 2012, 199; 213), Kilbegly, Co. Roscommon (O'Connell and Overland, 2013) show some increase during the Late Iron Age/Early Medieval period followed by a period of decline. Pollen analysis from the Wilkinstown Bog complex, Co. Meath for example is characterised by a substantial decline in hazel and ash values, and expansion of signals indicating pastoral farming activity for early medieval zone (Zone D 500-730 AD) (Newman et al 2007, 358). There is also a reduction in hazel pollen during the early medieval period from Cornaher bog, Co. Westmeath (O Carroll 2012), a signal of clearance in this landscape, particularly since the corresponding charcoal dataset from this region (N6 Kilbeggan to Kinnegad) comprised a high hazel component, reflecting the human response to wood collection from this clearance activity (ibid.).

The pollen data shows that ash and the Maloideae wood species were a component of secondary woodland, the result of clearance for agriculture during this early medieval phase (Aalen et al. 1997, 45). The ash and hazel decline recorded from some sites at this time, signals a period of intensive culling driven by anthropogenic factors, to facilitate this new wave of rath construction and occupation. This would therefore explain the notable rise in ash and Maloideae spp. woods from the charcoal record, particularly from many of the corn drying kilns and structures from about the sixth century AD, a reflection of increased woodland clearance, the product of which was brought to site and used for a variety of primary (e.g. structures and manufacturing) and secondary (e.g. firewood/fuel) use.

The early medieval kilns dating from the early sixth century at many sites excavated in Ireland also see an upsurge in scrubby species (Maloideae, *Prunus* sp., holly and ash) **(see Table 6.3.1 below).** In broad terms, the picture emerging from Late Iron Age kilns, albeit from a small sample set, it that hazel and/or oak are the dominant species present. If the wider range of charcoal studies from this period is measured, a pattern of hazel and oak variance seems to persist and dominant archaeological features dating to this period (O'Donnell 2018). The N8 Cashel to Mitchelstown road scheme revealed oak to be the dominant taxa from Iron Age dated sites, while a rise in hazel and ash was noted from the Early Medieval period in this landscape

(O'Donnell, 2009, 246). The charcoal analysed from the Ballynora to Lehenaghamore scheme in Co. Cork showed a dominance of hazel from Iron Age sites, shifting to oak during the Early Medieval period, with a notable rise in ash also (Lyons, 2015b, 308). A comprehensive study of the charcoal data from the N6 Kinnegad to Kilbeggan scheme in the midlands (O Carroll, 2012) revealed a mix range of taxa (ash, hazel, oak birch, Maloideae and *Prunus sp*.) from Iron Age dated sites, with a rise in oak from the Early Medieval period in line with a noticeable decline in ash, Maloideae and *Prunus* species.

The picture emerging then between the Late Iron Age and early medieval transitional period reproduced through the corn drying kiln dataset is one reflecting a shift from using predominantly hazel or oak to a mixed wood assemblage, where there is a rise in ash, oak Maloideae, *Prunus* species, holly and others being used to fuel these features. Considering the pollen data for this period and other comparative charcoal datasets, this upsurge in wood diversity from the archaeological record most likely reflects the human response to the increase in land clearance for agriculture and new settlements during this time.

6.3.2 Early Medieval Period (6th – 9th cen. AD)

The majority of the corn drying kilns from this study date from the late sixth to the ninth/tenth century AD and one of the most striking trends to emerge from the charcoal dataset is the continued use of mixed wood species (see above), interspersed with periods of low or dominant oak charcoal. As previously mentioned, there is a notable rise in ash and Maloideae species from kilns dating to between *494–602 AD (95% probability)* **(see Chapter 5; Section 5.5.6),** attributed most likely to the increase in land clearance for agriculture that began in the century or two before. Components of secondary woodland, which developed during the Late 'Iron Age Lull', would have provided a mixed supply of wood resources to meet the demands of the growing rath population that commenced sometime between the fifth and sixth century AD.

Through the Bayesian modelling of the kiln dataset, this period of mixed wood use, as represented in the kiln charcoal record, is estimated as lasting between *202-400 years (95% probability)*, ending *c. 800-993 AD (95% probability)* **(see 5.5.6).** If a mixed wood assemblage in the archaeological charcoal record represents the wood collection strategies employed as a response to periods of land clearance, and kilns are a proxy for charting on-site wood use, then these trends reflect episodes of land clearance that were occurring during this phase of the early medieval period. Corn drying kilns at Baysrath, Kellysgrange, Milltown, Kilree (Site 4), in Kilkenny and Gortmakellis, Borris (AR33) and Hughes' Lot East, in Tipperary all date to within this period between the sixth and tenth century AD and comprise of this mixed wood charcoal assemblage, where ash and/or Maloideae species are prominently present. If the wider corn drying kiln record is reviewed, a similar trend is evident **(Table 6.3.1)** from contemporary sites in Meath, Kildare, Cork and Galway. When the pollen evidence for this period is consulted, land clearance signals are varied across different regions and difficult to discuss chronologically, in the absence of a high resolution dating profile.

Table 6.3.1 List of other excavated corn drying kilns from early medieval Irish sites showing salient patterns of wood taxa identified

Phase	Date	Site name	County	No/ of kilns analysed	Salient trends in wood charcoal	Dominant wood in metalworking features	Dominant wood in structural deposits	Reference
Late Iron Age	3rd to 5th cen. AD	Lismullin	Meath	1	*Corylus avellana* and *Quercus* dominant			ASDU, 2009a
		Kilmainham 1C	Meath	1	*Corylus avellana* and *Quercus* dominant			O'Donnell, 2010a
		Blundlestown 1	Meath	1	*Corylus avellana* dominant			ASDU, 2009b
		Baronstown	Meath	1	Maloideae spp. and Crataegus monogyna dominant			ASDU, 2009c
	4th to 5th cen. AD	Chapelbride 4	Meath	1	*Quercus* dominant			ASDU, 2010
		Castlekeernan 1	Meath	1	*Quercus* dominant			ASDU, 2008
Early medieval period	5th to 6th cen. AD	Grange 2	Meath	1	*Quercus* dominant	*Quercus*		O'Donnell, 2010b
		Gardensrath 2	Meath	1	*Quercus* dominant	*Quercus*		O'Donnell, 2010b
	5th to 7th cen. AD	Pottlebarn 3	Meath	1	*Corylus avellana* and *Quercus* dominant			ASDU, 2009d
		Baronstown 1	Meath	3	Maloideae spp., *Prunus* and *Corylus avellana* dominant; *Fraxinus excelsior* and *Quercus* low	*Corylus avellana*	*Corylus avellana; Quercus; Fraxinus excelsior*	ASDU, 2009c
	5th to 7th cen. AD	Parknahown 5	Laois	3	*Quercus* dominant; lower mix of Fraxinus excelsior, Alnus, Corylus avellana, and Maloideae spp.; *Quercus* and *Fraxinus* did not appear to the same kiln	*Quercus*		O Carroll, 2009a
	5th to 10th cen. AD	Raystown	Meath	7	*Prunus spinosa* dominant; Lower mix of *Alnus, Ulmus, Corylus avellana, Fraxinus excelsior, Quercus, Prunus* and Maloideae spp.	*Quercus*		O Carroll, 2009b
	5th to 11th cen. AD	Johnstown	Meath	6	*Quercus, Fraxinus excelsior* and Maloideae spp. dominant; *Quercus* and *Fraxinus* did not appear to the same kiln	*Quercus*	*Quercus*	O Carroll, 2004a
	5th to 8th cen. AD	Castletown Tara 1	Meath	5	*Fraxinus excelsior* dominant; Lower *Alnus, Corylus avellana, Prunus; Quercus* absent		*Corylus avellana; Fraxinus excelsior*	ASDU, 2009e
	6th to 10th cen. AD	Roestown 2	Meath	4	Mixed - *Alnus* and *Quercus dominant ;* lower *Corylus avellana, Sambucus, Prunus*, Maloideae spp.; *Fraxinus* low			O Carroll, 2009c
	7th cen. AD	Randelstown	Meath	2	Maloideae spp., *Corylus avellana* and *Ilex aquifolium* dominant; *Quercus* absent			Dillon, 2006
	7th to 8th cen. AD	Dowdstown 2	Meath	2	Mixed - *Alnus, Fraxinus excelsior, Prunus spinosa, Prunus*, Maloideae spp.; *Quercus* low	*Alnus glutinosa*	*Corylus avellana; Fraxinus excelsior*	ASDU, 2009f
		Clonfad 3	Westmeath	1	*Corylus avellana* dominant; *Quercus* absent	*Quercus*		O Carroll, 2005
	7th to 9th cen. AD	Castlefarm 1	Meath	2	Mixed - *Alnus, Corylus avellana, Salix, Ulmus, Prunus*, Maloideae spp.; *Quercus* low	*Corylus avellana*	*Corylus avellana; Fraxinus excelsior*	ASDU 2009g
		Ballybrowney Lower	Cork	3	*Quercus* or *Fraxinus excelsior* dominant; *Quercus* and *Fraxinus* did not appear to the same kiln		*Quercus*	O Carroll, 2006

Phase	Date	Site name	County	No/ of kilns analysed	Salient trends in wood charcoal	Dominant wood in metalworking features	Dominant wood in structural deposits	Reference
Early medieval period	8th to 10th cen. AD	Dowdstown 2	Meath	3	*Corylus avellana* dominant; lower mix of *Fraxinus excelsior, Quercus, Prunus* and Maloideae spp. *Quercus* low	*Alnus glutinosa*	*Corylus avellana; Fraxinus excelsior*	ASDU, 2009g
	8th to 9th cen. AD	Charlesland	Wicklow	2	*Quercus* dominant			O'Donnell, 2004
	8th to 9th cen. AD	Corbally	Kildare	2	*Corylus avellana* dominant; lower mix of *Fraxinus excelsior, Ilex aquifolium* Maloideae spp. *Quercus* absent		*Corylus avellana*	Stuijts, 2002
	8th to 10th cen. AD	Killickaweeny	Meath	2	*Fraxinus excelsior* dominant; *Quercus* low or absent	*Fraxinus excelsior*	*Corylus avellana; Fraxinus excelsior*	O Carroll, 2004b
	8th to 11th cen. AD	Loughbown 1	Galway	2	*Quercus* and *Prunus* dominant	*Quercus*	*Corylus avellana; Fraxinus excelsior*	Dillon, 2007
		Mackney 3	Galway	1	*Prunus spinosa, P. avium* and *Prunus* sp. dominant	*Quercus*		Dillon, 2008
		Toberbracken	Galway	2	*Fraxinus excelsior* dominant; Lower mix of *Alnus, Corylus avellana, Betula, Prunus* and Maloideae spp.			Dillon 2010a
		Owenbriskey	Galway	2	*Fraxinus excelsior* dominant; *Quercus* low or absent	*Fraxinus excelsior*	*Corylus avellana; Fraxinus excelsior*	Dillon 2010b
High medieval	10th to12th cen. AD	Ballyglass West 1	Mayo	1	*Quercus* dominant	*Quercus*		O Carroll, 2010
		Ballinvinny North	Cork	1	*Quercus* dominant			O'Donnell, 2003
Late medieval period	13th cen. AD	Clonfad 3	Westmeath	1	*Corylus avellana* dominant	*Quercus*		O Carroll, 2005
	13th to 14th cen. AD	Doneraile	Cork	1	*Quercus* dominant	*Quercus*		Lyons, 2010
	14th to 15th cen. AD	Stagspark 2	Cork	1	*Quercus* dominant			Sutton, 2006
	15th cen. AD	Tonaphort 3	Westmeath	1	*Fraxinus excelsior* dominant	*Quercus*		O Carroll, 2012
	15th cen. AD	Derrinsallagh	Laois	1	*Alnus glutinosa* dominant	*Quercus*		O Carroll, 2009d

Examples from Abbeyknockmoy, Co. Galway (Clarke and Barber, 2003), Kilbegly, Co. Roscommon (O'Connell and Overland 2011), Mongan and Clonfert Bog, Co. Tipperary (Hall, 2005; Hall and Mauquoy, 2005) and Monaincha Bog and Derryville, Co. Tipperary (Hall 2002) all provide broad overviews of the woodland composition and how it was impacted upon by agricultural expansion during this time, but fails to chart how often periods of clearance occurred, how woodland was managed or indeed the human response to fluctuating patterns of clearance and woodland regeneration. By constraining the kiln chronology used in this thesis, it is possible to produce a statistically probable timeframe for when the most intense periods of land clearance were taking place during the early medieval period. This is likely to have occurred over a period of between 200 and 400 years between the early fifth and late ninth century AD **(see Chapter 5; Section 5.5.6).** While this coincides with the results from the various pollen records, the kiln dataset have not only narrowed the timeframe for this occurrence but have potentially provided a plausible *terminus post quem* and *terminus ante quem* for the most extensive landscape clearance phase and in turn, settlement growth of the early medieval period.

In addition to this, the kiln charcoal record is demonstrating that episodes of woodland clearance may have been more intensive at certain times, which would explain this diverse wood composition interspersed with a fluctuating use of oak and ash from many of the kilns analysed not just between sites but within the same sites. Examples of an oak charcoal dominance in kilns were found at Ballykeoghan, Scart and Knockadrina, in Kilkenny and Borris (AR33) and Hughes' Lot East, in Tipperary. Interestingly, the latter sites also had contemporary kilns which contained a high diversity of mixed wood taxa, this trend potentially signalling bouts of woodland clearance in these locations. At Kellysgrange, Milltown and Kilree (Site 3), in Kilkenny, ash charcoal dominated kiln deposits, again from sites with kilns containing a mixed wood assemblage (Kellysgrange and Milltown) **(Chapter 4; Section 4.3.4).**

The contradictory use of oak and ash, albeit tentative, was one of the observed outcomes from the charcoal results for this period and so requires further attention.

Through the statistical analysis and the individual site case studies from Hughes' Lot East, Toureen Peckaun and Twomileborris (Borris AR33 and Borris/Blackcastle AR31), in addition to the feature case study of the corn drying kilns **(see Chapter 5),** it is plausible to assume that there existed an interdependent relationship between oak and ash prior to the tenth century AD. This is especially evident in the period between the late seventh and late ninth/early tenth century AD, when ash values are at their highest and oak is at its lowest signal overall, despite episodes of a dominant oak from some sites, such as Twomileborris (Borris AR33), Moycarkey Site 12/13, Farranamanagh in Tipperary and Ballykeoghan, Coneykeare, Danesfort and Kilree in Kilkenny **(see Chapter 4; 4.3.4, 4.3.5).** Through the charcoal record, the interpretation is that ash, together with other mixed taxa, may be facilitating an oak shortage at certain times during this period and that oak is being prudently used or being reserved for specific activities.

This trend is noted not just between sites, but within sites themselves, demonstrating that oak stock may be economically, seasonally or functionally driven. This therefore poses some interesting questions on the state of oak and oak woodland during this time and if it's irregular distribution is an indicator of local supply and demand strategies driven by anthropogenic and/or environmental factors. As this is one of the most significant outcomes from the results of this thesis, the nature and role of oak during the medieval period will be further explored in **Section 6.3.4** with a view to explaining its fluctuating presence in the archaeological charcoal record.

6.3.3 Early Medieval (9th-12th cen. AD) and Later Medieval Period (post-13th cen. AD)

The latter part of the medieval phase dating from the late ninth century AD and later into the late twelfth/thirteenth century and beyond is largely characterised by the rise and dominance in oak charcoal. This period was also defined by a notable decrease in ash and the invariable use of fruitwood species (Maloideae and *Prunus* sp.) and other minor taxa, a pattern which was recorded from kilns at Coolmore, Kilree (Site 3), Leggetsrath East, Scart and Scart/Rahard in Kilkenny and Boscabell, Borris/Blackcastle and Monadreela (Site 8) in Tipperary. The start of this phase of oak dominance is estimated as occurring between *800–993 AD (95% probability).* This date range is a significant one within the context of Irish medieval studies, as the archaeological and historical evidence details a prominent shift in the medieval social structure at the end of the first millennium AD.

There is a general consensus between historians, historical geographers and archaeologists that there were significant political, social and kinship changes from c. 800AD onwards, and particularly in the tenth and eleventh century (Graham 1993, Ó Corráin 1995, Doherty 1998, O'Keeffe 2000). These reputed socio-economic changes include the decline of petty kingdoms, as local kings and chieftains lose their power, and the emergence of regional polities, with a rise in more powerful provincial kings, in the eleventh and twelfth century (Ó Corráin 1995). Whereas the earlier medieval ecomony was one based on kinship and reciprocity, this later period becomes more centralised, where it is postulated that there is a greater social divide with a labour service being provided to a regional figure head (Doherty 1998, 322-4).

Economically, it is also suggested that from the ninth century a 'market economy' develops controlled largely by the church. There is a shift from using cattle as a currency to silver bullion/coinage (Doherty 1980, Sheehan 1998); and with a rise in larger sized corn drying kilns (Monk and Power 2012), there seems to be a move away from subsistence farming to the production of agricultural surplus controlled by the political elite (McCormick and Murray 2007, McCormick 2008). This also signals a time with the rath culture of the earlier period begins to decline as new territorial frameworks emerge and there is a relocation of population (Lyttleton and Monk 2007, O'Sullivan et al. 2013, 329, Stout 2017).

This period is also defined by the arrival of the Vikings to Ireland, with the earliest campaigns beginning between 794 and 807 AD. After 807 AD there was more conflict on the mainland of Ireland, with intensification during the 830's which became spread across the island. During the tenth and the eleventh century, Vikings towns develop in Dublin, Wexford, Waterford, Cork and Limerick, ushering in a new form of urban market economy, where there is an increase in trade, manufacture and production (Wallace 1987). In political terms, the emergence of more pyramidal organised regional powers, with a king overseeing officials that ruled territories on their behalf was occurring from the late tenth century AD (Ó'Corráin 1978, 28-29, Lyttleton and Monk 2007, 17). This new aristocratic elitist structure developed into a more militant and centralised society, with a growth in castles, bridges, navel fleets and cavalry units, possibly as a consequence of population pressure and/or an economic downturn during the tenth century (ibid.).

In the archaeological record, a prominent signal for a changing settlement structure is found in house styles. From c. 800AD, there is a change from post and wattle round houses to a more robust form of rectilinear house, defined by slot trenches (Lynn 1978, 29-45). Towards the end of the tenth and eleventh centuries rectangular houses were becoming the norm, with some replacing round houses on most ringfort sites (ibid.).

From the twelfth century onwards corn drying kilns at Monadreela, Borris/Blackcastle (AR31) in Tipperary, and Shankill in Kilkenny contained a higher occurrence of oak overall, along with oak from occupation evidence on later medieval sites at Windmill and Moycarkey in Tipperary and Danesfort (Site 6) and Earlsrath (AR33) in Kilkenny. This period is defined by the arrival of the Anglo-Norman colonisation, where new settlement, agricultural and administration structures dramatically changed the earlier system. Overall, the extent of settlement excavated from later medieval sites was not as extensive as the earlier period and as a result it was difficult to chart continuous changes to wood use during this period due to a general absence of sampling on these sites, which is a common occurrence. That said, the range of features sampled met the sample sufficiency criteria for this thesis and the charcoal results did display a high oak signal, where >50% of the samples contained oak.

The socio-economic and political changes that were occurring from the ninth/tenth centuries in Ireland and the later Anglo-Norman settlement are therefore significant in helping to understand the change in wood resource use and woodland management during this time. Since this period is characterised by dominance in oak use, coupled with a decrease in the use of mixed wood taxa, it raises some interesting questions about the nature of the later medieval woodland, resource control and the types of wood management strategies now at play. The following section will discuss this oak conundrum and puts forward hypotheses based on the results of this study to explain the variability in the oak signal prior to the tenth century and its dominance in the later period.

6.4 The Oak 'Conundrum'

As presented and discussed in Chapter 4 and Chapter 5, oak as a resource during the medieval period was in a state of flux, particularly between the late seventh and late ninth/tenth century AD. The main points of interest that have emerged are a) the fluctuating use of oak that appears to be a feature of sites pre-dating the tenth century AD; b) the increase in oak on sites when the use of other taxa decreases and c) the decline in species such as ash from the majority of the sites dating to the tenth/eleventh century and into the later medieval period, while oak values remains high and constant where recorded. The distribution of oak is higher overall from sites in Kilkenny compared to those in neighbouring Tipperary. Since the results of the charcoal analysis is showing that wood resource use is being culturally driven during this period, then oak was more available for use in Kilkenny then in Tipperary, where supply would have been determined by its relative abundance in the landscape.

The case studies used highlighted the broader picture of ash reduction and oak increase from the post-tenth century AD period, a trend similarly recorded from Moycarkey (Site 15), Boscabell (Site 19), Monadreela (Sites 8, 9, 11 and 12), Twomileborris (Borris/Blackcastle AR31) and Windmill in Co. Tipperary and Tinvaun Site 3, Scart, Scart/Rahard, Riceland, Coolmore, Earlsrath and Leggetsrath in Co. Kilkenny. This pattern indicates that ash is either not available or not being used in the same way from about the tenth century and further into the twelfth and thirteenth century and beyond. It is possible that local ash supplies were depleting at this time due to high demand or use during the earlier medieval period, however, there is no documentary evidence pertaining to this, nor is it something that is reflected in the pollen recorded for this period.

While ash is clearly still a component of later medieval charcoal assemblages, such as Mondareela, Leggetsrath, Tinvaun and Shankill for example, albeit low, its decline may not be an environmental factor, but a product of anthropogenic agents driven by various cultural dynamics and new woodland management strategies. To explore these issues further, with a view to explaining the role of oak and inadvertently ash during these distinct phases, it is necessary to engage with the historical record and different strands of archaeological evidence available to try and elucidate this subject.

The Documentary Evidence

As outlined in Chapter 1, the early law tracts provide a significant source of information on how wood and woodland was viewed and treated in early medieval Ireland. Oak and ash were both held in high esteem, classed (ibid.), which shows that they held equal value. The legal commentary highlights the value that was placed on oak trees and oak fences during this period, which clearly reflects the importance of this resource in medieval Ireland, where detailed statutes governing its protection needed to be written down. While the origin for the principles of these laws is obscure, many of the specific details discussed above are based on texts, which were devised in the late-seventh and eighth century AD (O'Kelly 1988, 1).

This sophisticated and complex legal system, which obviously made a concerted effort to include a set of laws governing wood use, had to be based on preserving or conserving this natural resource. This strongly implies that there was a need to regulate and protect wood and woodland, particularly oak, but what were the reasons for this and why do they date specifically from the seventh and eighth century period?

While the pollen evidence does not help to explain the nature of oak growth in the Irish early medieval landscape (Hall 2000, 345; Hall 2003, 15), the literary sources instead, provide some insights into the presence of oak during the period between the late seventh and ninth century AD. There is frequent recording of abundant oak-mast, or acorn production from the annals (672AD, 760AD, 769AD, 773AD, 806AD, 836AD, 935AD, 950AD and 981AD) (Mac Airt and Mac Niocaill 1983) which clearly indicates that oaks were growing, even if absent periodically from the archaeological record during this time.

Dendrochronology

One of the most defining areas of archaeological research that has emphasised an oak conundrum during the early medieval period in Ireland is dendrochronology. The establishment of the oak chronology highlighted some interesting gaps in the record, representing missing generations of oaks e.g. 750 AD and 833 AD 926 +/-9 AD and 1033 +/-9 AD, suggesting there was no building using long-lived oaks during these periods (Baillie 1977, Mallory and Baillie 1988).

A more recent review of these dendrochronological dates, fuelled by the increase in the number of water-mills and crannóg sites, such as Nendrum, Co. Down (Lynn and McDowell 2011) and Deer Park Farms, Co. Antrim (Baillie and Brown 2011, 558-567) have helped to fill some of the gaps. The 650 to 720 AD gap is still there, however a suite of dates have now been obtained for after 720 AD, intensifying further between c. 800 to 850 AD, after which point there is a clear reduction and a thinning out of sites between c. 930 and c. 1030 AD (Baillie and Brown 1995, Baillie and Brown 2011, 560). While the number of original dates has doubled, overall these new additions do not significantly change the trend observed (Mallory and Baillie 1988), implying that this distribution is a reflection of some real information regarding the rate of construction across Ireland during specific periods of time.

Medieval water-mills

While much of our information on mill use, construction and cultural identity traditionally comes from the historical sources (Lucas 1953, Mac Eoin 1981, Kelly 1997, 484, Rynne 2000b, 3-12) the increase in archaeological excavations, particularly from well-preserved anoxic deposits, have offered tangible evidence of these features and are showing that oak was the primary material used in their construction. Wooden mills and their associated structures recorded at Nendrum, Co. Down (McErlean and Crothers 2007); High Island, Co. Galway (Rynne 2000a, 15–17); Inishmurray, Co. Sligo (O'Sullivan and Carragáin 2008, 246-251); Killoteran (Russell 2011), Kilbegly, Co. Roscommon (Jackman et al. 2013) and Twomileborris, Co. Tipperary (Ó Droma 2008) all revealed oak to be an important resource and used in a variety of structural mill components.

An appraisal of the radiocarbon and dendrochronological dates from these features sees the majority of them dating from the mid-eighth century to the mid-ninth century AD (Rynne 2013, Brady 2006), coinciding with this period of irregular oak use being reflected through the charcoal record. Similar to early churches, the archaeological record shows oak was obviously the wood selected primarily for mills also and there are many laws pertaining to mill construction, maintenance and fines for damaging such a structure (Binchy 1978, CIH, ii, 564.36; iii, 781.2; Kelly, 1997, 484).

If the dendrochronological evidence of oak samples from mill sites is further scrutinised, they provide some very significant details that may offer insights into this oak debate. A felling date of 619-621 AD was obtained from the earliest phase of mill construction at Nendrum (Mill 1), where mature oaks surviving *in situ* with an age range of 130-250 years recorded (Earwood 2007, 223). At Killoteran, Co. Waterford, a series of oak timbers produced a dendrochronological felling date of 612/613 AD. Interestingly, it was noted that the timber planks were taken from the one tree, as many as 14 in one case (Brown 2011). This suggests the use of very large oak trees and an efficient use of producing large planks. The construction of a second mill at Nendrum (Mill 2) had a relative absence of oak and those recovered were largely too small for dating, with just one timber being suitable (125 years), yielding a felling date of 788-799 AD, possibly in use until the tenth century AD (McErlean and Crothers, 2007, 111).

It has been surmised that Mill 2 was dismantled, and that its large oak timbers were salvaged for reuse when the mill ceased to function, which implies that at some point during the eighth and tenth century AD, oak was becoming a locally exhausted resource with a need to salvage from elsewhere (McErlean 2007, 254). The date of the Kilbegly mill, Co. Roscommon is estimated at having its floruit between mid-seventh and late ninth century AD (Jackman 2013, 39-40). Interestingly, the samples sent for dendrochronological dating were largely unsuited as the sapwood was absence and yielded an early date of 534 AD–601 AD, which was postulated as being a re-use of timber form an earlier source (ibid.). Instead the dating programme relied on 34 radiocarbon dates obtained for the site (ibid.). Although many oak timbers from Kilbegly contained between 25 and 200 growth rings, the presence of sapwood from many of the elements may represent immature oak woodland, and that larger oaks may have been scarce (O Carroll 2013, 57).

The surviving oak timbers from mills excavated at Raystown, Co. Meath indicate the sheer volume of wood needed to build these structures which dated from the early eighth century AD to the twelfth century AD (Seaver, 2016). The oak timbers sampled for dendrochronological dating were all deemed unsuitable based on an insufficient number of growth rings. An attempt was made (Brown 2005) to produce short sequences, but the results did not fit the criteria for definitive dendrochronological dating and so like Kilbegly, radiocarbon dating was used to resolve the mill chronology. The analysis also revealed that some oak samples were warped, suggesting isolated corpses of trees buffeted by the wind so oak may have been difficult to source (Brown, 2005; Seaver, 2016, 102).

The overall evidence for timber use for early medieval watermills in Ireland suggests (based on approx. 160 sites) (Rynne pers. comm.) there was never any shortage of good quality timber from the seventh to the eleventh century, but an assessment of the wood dataset does however strongly imply that the oaks used during this time were largely from younger trees compared to earlier examples.

It is also worth mentioning that there was an increase in the use of stone in the northern and central mill complexes, dating from the tenth and eleventh century AD, perhaps implying a scarcity of suitable oak timber during this time (Seaver, 2016, 85, 102). The use of stone in church building in Ireland also sees an increase from the eleventh century (O’Carragáín 2010, 87), so perhaps the move away from using wood was becoming a wider tradition at this time. Whether this was a product of a depleting oak resource or a cultural change to building style is still unknown in the archaeological record.

Crannógs

In addition to water mills, the dendrochrological evidence from Moynagh Lough crannóg, Co. Meath revealed evidence for a reused timber (felling date AD625) from a wooden pathway (Phase X) (Bradley, 1982-86; Bradley, 1990-1). The palisade associated with the uppermost occupation layer at the site (Phase Z; c. 780-810 AD) was constructed using young oak timbers (ibid.), suggesting perhaps a scarcity of mature oaks during the eighth and ninth century phase.

In light of this evidence large mature oaks, recovered from the earliest phases at Nendrum and Killoteran, seem to be available for mill construction dating to the early seventh century AD. In contrast, by the early eighth century AD, according to the evidence from known wooden mills, younger oaks of a lesser quality were being used from contemporary sites in the north, east and midlands. This strongly suggests that during the period between the seventh and eighth century, mature oak woodland were declining or receding and undergoing a period of regeneration. This would explain a) the re-use of an earlier timber for the Kilbegly mill and Moynagh Lough crannóg; b) the immature oaks used at Raystown and the later mill phase at Nendrum and c) the absence of large oak timbers from later Mill 2 at Nendrum.

This elusive period of oak use between the mid-seventh century AD and the mid-ninth century AD with respect to construction activity represented in the dendrochronological record could instead highlight a period of prudent oak use. The impetus for this may lie in a dearth of mature oak trees, where early medieval communities were becoming increasingly aware of this depleting resource, which ultimately inspired the law tracts governing wood and woodland. A declining oak supply sometime during the seventh century may have been the catalyst for devising this legal structure, a strategy to raise the profile and encourage the use of other wood taxa, such as ash and pine (e.g. Medb and Ailill at Crúachain) (Mallory and Baillie 1988, 27) for building and construction works. Such an approach may have been necessary in order to conserve oak resources and avoid exhaustion. A change in social behaviour towards oak was suggested by Mallory and Baillie (1988) as a possible reason for an absence in oak construction during this time. While the gaps in the dendrochronological medieval oak sequence has traditionally been interpreted as a hiatus in construction (Baillie 1995, 39), the charcoal record contradicts this, showing instead that, while oak continues to be used in construction, its supply and demand is most likely locally derived and seasonally driven.

The pressures put on oak during this period of intense building (O'Sullivan, et al. 2013) and landscape organisation together with extreme climatic oscillations **(see**

Chapter 1; Section 1.6.5) which may have hindered oak growth for a time, seem a conceivable stimulus for ushering in a period of stringent oak management. A depletion or absence of oak supply would have necessitated a change in human behaviour, where conservation of this resource would have prompted a new system of woodland management. Until now, other strands of palaeoecological evidence failed to fully support this theory. The charcoal record is therefore suitably placed to demonstrate that while oak was being used in building, it was variable and inconsistent, so how was it now being prioritised and what type of wood management strategies did this evoke.

Metal working

The fuel used in industrial activities, such as metalworking and charcoal production, which largely relied on oak resources, cannot be overlooked, the evidence of which survives only in the charcoal record. The high oak component from metalworking features in this study and wider comparanda, is revealing that rarely is oak being overlooked in relation to these activities (smithing and smelting). The archaeological record is showing that ironworking provides the most abundant evidence for industrial activity from the early medieval period in Ireland and was widely practiced both geographically and socially (O'Sullivan et al. 2013, 243). Despite the vast corpus of new archaeological evidence for ironworking, this subject still lacks a cohesive chronology to understand any changes to this industrial and technological activity over time (Kerr et al. 2012, 22). As a result it is difficult to explain if the metalworking industry was going through a phase of technological development between the seventh and ninth century AD, where there was a continued emphasis on using oak during this time.

Much of our understanding of the organisation of metalworking in early medieval Ireland has been derived from the law tracts (*Uraicecht Becc* and *Tech Midchuarta*) (Scott 1991, 187) dating to this time. The metallurgical evidence from recent excavation schemes in Ireland has allowed discussions by archaeologists and archaeometallurgists on the regional patterns and the various levels of metalworking found on early medieval sites (Carlin 2008, 87-112; Wallace 2010b). Despite this however, excavations have revealed considerable variability in the extent and character of evidence at various forms of settlements (Kerr et al. 2012, 39).

Metalworking debris (slag) varies substantially from site to site (Wallace 2010b, 73) and it is apparent that there is no simple equation to be made between the type or perceived status of a site and the scale of iron-working carried out within it. It is often difficult to determine the duration and extent of the iron-working activity at some sites (e.g. Johnstown, Co. Meath) skewing our perception of the character of iron-working at these locations.

The site at Twomileborris, Co. Tipperary, where both primary and secondary iron working were recorded, in addition to non-ferrous metalworking and craft working (Wallace 2010b, 80-82) comprised a charcoal assemblage that was dominated by oak during all phases of medieval activity. Along the M4 Kinnegad to Enfield to Kilcock (counties Westmeath, Meath and Kildare), early medieval iron working was identified from a range of contemporary sites dating from between the sixth and eleventh century AD (e.g. Johnstown 1, Killickaweeny 1, Rossan 4, Hardwood 3, Newcastle 2 and Ardnamullan 1). If the charcoal record for these sites is reviewed, some interesting results come to light.

Not surprisingly, oak dominated from sites where charcoal production was present (Hardwood 3, Newcastle 2 and Ardnamullan 1). At Johnstown 1, which contained primary iron processing as well secondary bloomsmithing, forging and repair and production of iron objects (Photos-Jones 2008) oak dominated the charcoal assemblage overall, particularly from smelting pits and hearths (O Carroll, 2004). The high slag content recorded suggests that all phases of processing occurred there (Photo-Jones 2008). The drying kiln did not contain the same level of oak charcoal, which was clearly present at the site, instead ash and Maloideae woods dominated from these features. In contrast neighbouring Killickaweeny, another contemporary iron working centre just 20km away contained predominantly ash charcoal (Walsh 2008). Alder was the wood of choice in metalworking features at Dowdstown (Cagney and O’Hara 2009) and hazel at Baronstown (Linnane 2007) both in county Meath. In the west, contemporary iron working sites in county Galway also displayed a disparity in wood taxa, where ash was found in smithing pits at Owenbriskey, with oak dominant at Loughbown 1 and Mackney (Delaney 2009) **(see Table 6.3.1)**

With oak largely the wood of choice being selected for ironworking activities, it raises questions then about when oak was used. Was metalworking a seasonal activity for example which dictated oak supply and use at a site. Several references from the medieval and Middle Ages in Britain and beyond cite that iron smelting was undertaken during the winter months, after the harvesting season (Beresford and Joseph 1979, 259, Gogoi 2002, 98, Pounds 2014, 325). Similarly, ethnographical examples from Kenya have shown that ore-collection and smelting were seasonal activities and only carried out after all the harvesting was done (Brown 1980, 58-59). Forging on the other hand could be carried out all year round as demand necessitated it (ibid.). This winter use of oak for iron working would coincide with corn drying activities **(see Chapter 5; Section 5.5)** and may explain the dominance of oak charcoal from these features at some sites within this study and beyond.

This appraisal of oak in the context of metalworking activities demonstrates that while oak was primarily used for both primary and secondary ironworking, its presence on sites was again variable. This suggests that oak was not always a priority resource on sites which functioned as metalworking centres and that it may have been scarcer in some areas or at certain times, where ash was used in its place (e.g. Killiackaweeny).

Charcoal production

Oak is also the primary wood taxon recorded from medieval charcoal production kilns/pit (Cleere and Crossley 1995, 37, O Carroll 2012, 51) a distinct feature that has emerged from the archaeological record in recent years (Kenny 2010, 99-116) Charcoal would have been hugely important in the smelting and working of ferrous and non-ferrous metals, glass and other craft industries. To achieve the temperatures necessary for iron-smelting and smithing (eg. 1,100-1,200° C discovered from samples at Lowpark, Wallace and Anguilano 2010), charcoal production was necessary as wood itself could not accommodate such activities (Rackham 2006, 203, Kenny 2010, 99). Very little is known historically about the charcoal production process during the medieval period (Tylecote and Tylecote 1992, 225) however, the upsurge in archaeological excavation in Ireland has changed this and brought an increased awareness to these features and how they should be studied (Kenny 2010, 99).

The vast bulk of these are found throughout the midlands in counties Laois, Offaly, Tipperary, Westmeath and Kildare (ibid.). A dating profile has revealed that the majority of them date from late-eighth and early-eleventh century, with a general absence in the fifth, sixth and seventh centuries (Kenny 2010, 109; O'Sullivan et al. 2013, 220). However, since oak was the preferred timber in charcoal making, the dates obtained for these pits may suffer from the 'oldwood effect' (Warner 1990), and so caution must be exercised when interpreting each date.

If this evidence however is to be trusted, it implies that there was an expansion of charcoal production in Ireland from the later eighth century AD. Again, the earliest dates for charcoal production pits fall into the date range parameter for irregular or sporadic oak use. If local oak resources were under pressure from the late seventh century, then by creating an industry to ensure a readily available supply of oak charcoal would allow domestic, industrial and craft activities to continue without much disruption. Modern ethnographic case studies, such as that from northeastern Peru found that traditional peasants, when faced with limited access to new land, turned to charcoal production (Coomes and Burt 2001, 48).

Charcoal being a sterile lightweight material, would also facilitate long-term storage and would have been easier to transport than large unworked timbers. A pound of charcoal produces more heat than a pound of wood (Rackham 2006, 203). The production of charcoal by traditional methods does not involve the use of any specialised tools and so it is likely that early medieval farmers with access to wood resources, however limited could produce their own charcoal (Edwards 1996, 86; Kenny 2010, 113). The eighth-century law tract *Críth Gablach* lists among the household possessions for one grade of farmer 'a sack of charcoal for irons' (Scott, 1991, 100; Kelly 1997, 332) implying that households had their own stack of charcoal for iron production.

O Carroll's study (2012) of charcoal production pits along the N6 Kinnegad to Kilbeggan road scheme revealed a plethora of these features in often isolated locations, suggesting that these sites were most probably situated close to abundant and suitable woodland sources, away from the main settlement areas (Carlin 2008, 108; O Carroll, 2012, 50). This seems to be the tradition in Anglo-Saxon England in the late seventh century AD, where iron-working was located close to woodland and away from settlement (Hinton 1998, 14). Ethnographical studies from Kenya also show that settlements containing established, industrial smithies were generally found closer to woodland and water sources and positioned some distance from living areas, compared to smaller more domestic smithing communities (Brown 1980, 5). Charcoal being a fragile material, would be difficult to transport long distances unless by river (Rackham 2006, 203), so access to nearby woodland would have been essential.

The *Early Medieval Archaeology Project* (EMAP) survey however shows that charcoal production pits were not exclusively distant from the settlement and were also found within or close to enclosures (O'Sullivan et al. 2013, 112). Despite location, charcoal production would have required a stringent approach to woodland management. In thirteenth century England, for example, measures were implemented to control wood clearance associated with charcoal production (Schubert 1957). The procurement, felling and processing of wood for charcoal production would have been demanding and laborious and based on current ethnographical evidence, considerable amount of time was given to this process (Coomes and Burt 2001, 42).

Analysis of charcoal from such features in Ireland, namely along the N6/M7/M8 road schemes through the midlands has shown that oak charcoal from small roundwoods varying in age of between 5 and 35 years, indicate some degree of woodland management and coppicing strategies (O Carroll 2008; 2012, 51). This would have certainly controlled the impact of charcoal production on local oak woodland resources as well as producing regular strands on a rotational cycle to satisfy local supply and demand. There is ample historical and archaeological evidence for charcoal-burning from Anglo-Saxon England, where the term col ('charcoal') is frequently used in charter boundary clauses, suggesting some degree of woodland management associated with this activity (Hooke 2010, 152).

Overview of the oak debate and wood resource change

An assessment of the archaeological, historical and literary sources has provided significant insights into the oak variability as depicted through the charcoal record for the early medieval period. This taxon, as demonstrated, seems to have come under increased pressure from the late seventh century AD, as a result of the preceding building boom in rath and crannóg construction. At this point a series of legal and economic measures were put in place to alleviate this depleting oak supply, encourage regeneration of the oak woodland and promote new methods to ensure its sustainability through the use of charcoal production. Based on this appraisal, it is hypothesised that this was the beginning of stringent and organised woodland management, a structure which continued up until the late ninth/early tenth century AD.

While evidence for coppicing is known from the prehistoric period (Orme and Coles 1985, Stuijts 2005), woodland management strategies for the medieval period are relatively unknown (Tierney 1998, O'Sullivan 1994) and to date no one discipline has been successful in fully ascertaining the origins or nature of these practices. It has been surmised that a *laissez faire* approach to woodland management existed during this period (Tierney 1998) and based on the results of this study, this may have been the case during the early centuries of the early medieval period, where the use of a mixed wood resource reflected stable conditions with access to a range of woodland taxa. Interestingly, this is also the picture being presented at Hoddom, where the use of a diverse wood supply, representing semi-natural woodland, implies a steady but informal wood management regime (Crone 2002, 149). The use of slow grown oaks also suggests that mature oak woodland existed or was available to the inhabitants at Hoddom during this eighth and ninth century AD (ibid. 150). The implementation of more rigorous woodland management occurs only when this type of mixed woodland becomes exhausted due to population and settlement pressures (Edlin 1956, 100).

Through the application of charcoal analysis, it has been hypothesised that a reduction in oak supplies from the late seventh century AD in Ireland was the main driver for changes in woodland management regimes occurring at this time. To prevent the total exhaustion or depletion of these semi-natural woodland reserves, regular and stable woodland management strategies would need to be put in place. Oak was clearly being used on a site at different times compared to other wood species strongly suggesting that oak was seasonally cultivated. Over-exploitation would have resulted in a decline in the quality and quantity of mature oak available, allowing instead for the growth and regeneration of younger coppiced wood.

Woods were integral to medieval daily life, a multi-layered ecosystem providing sources of firewood, charcoal, timber, food, medicine and even shelter in times of unrest. If communities mismanaged their woodland resources they were in danger of losing their self-sufficiency. If the oak woodland was being managed rigorously during these centuries with availability hindering supply and demand at certain times, then this resource would have been regenerating to maturity as part of this management strategy. In turn, this would then provide a readily available fully mature resource by the tenth century AD. This could therefore explain the sudden dominance of oak in the charcoal record from the tenth century and later. The impact of the socio-political and economic changes which date to the ninth/tenth centuries may have also effected and changed the earlier woodland management structure, where oak woodland now became an asset or property of a regional power, which had a different woodland agenda and management strategy driven by a new emerging labour and market economy.

In the case of the corn drying kilns, the construction of a longer flue, which is found in keyhole-shaped kilns dating from the ninth century AD (Monk and Power 2012), would have made drying more efficient but would have also prevented kilns from burning down. This new technological advancement would have contained and distributed heat more effectively (Monk and Kelleher 2005), which may have had an effect on the composition of fuel wood used. The high calorific quality of oak would have allowed this wood to survive high temperatures and as such may be over – represented in the archaeological record for kilns dating to the later period.

The shift to using stone in church construction more broadly (Ó'Carragáin 2010) from the eleventh century and the use of other materials in house building from the tenth century (Lynn 1994) would have also eliminated undue pressure on the oak supply for many construction projects. The rise in a fleet tradition of ship building during the tenth/eleventh centuries, where oak was the wood of choice (Swift 2004) would have required a mature oak supply. Such endeavours were the product of tribute and shipping campaigns of regional kings (ibid.), which would have made control of oak woodland and resources a valuable advantage and a symbol of power and prestige. Shipbuilding was also a prominent activity in Viking Dublin during the tenth and eleventh centuries, where oak was predominantly used (McGrail 1993, Halpin and O'Sullivan 2000).

Interestingly, oak did not form part of the construction of Viking houses in Dublin, compared to Viking Waterford (Reilly et al. 2014). Instead ash was the wood of choice, which questions the nature of wood provisions, supply, control and distribution in these urban centres (ibid.). The results of this charcoal study has revealed that oak remains high and constant from the tenth century, a trend that is supported by the corn drying kiln data also. In contrast, the charcoal recorded from structural deposits shows oak to be diluted by the presence of hazel, fruitwood species (Maloideae and *Prunus* sp.), alder and elm **(see Chapter 4; Section 4.3.4).** If the current archaeological evidence for structural wood is then considered, using the charcoal and wood assemblages, oak use seems to be prioritised elsewhere in some cases (i.e shipbuilding, metalworking and charcoal production (see above). A dominant oak in the charcoal record for later medieval ironworking at sites in Yorkshire was interpreted as being part of a rigorous woodland management (Wheeler 2007b), which may help to explain this oak use in a similar Irish context. The high oak recorded from many of the later dated corn drying kilns could therefore be the product of charcoal production rather than wood debris from on-site construction and manufacturing work, as was the case from the earlier period.

If oak provisions were therefore being used for specialised activities and with an established charcoal production industry *in situ* during this time, the mature oak woodland that became re-established between the eighth and tenth centuries may well have remained undisturbed within controlled areas under strict management. By the time of the Anglo-Normans arrival in the twelfth century, this woodland would have provided for the extensive building works that ensued into the thirteenth and fourteenth century. Oak was well documented as being part of the Anglo-Norman fuel and building provisions (Slattery 2009) and with their new approaches to woodland resource management, through a system based on rotational coppicing and taxation (ibid.), woodland resources became a commodity that saw a gradual decline and exhaustion by the fifteenth century AD (McCracken 1959), a decline that is also recorded through contemporary pollen records (Hall 1995, Hall 2000).

6.5 Seasonality in the charcoal record

A novel approach used in this thesis has been to compare the charcoal record to crop assemblages from corn drying kilns with a view to understanding more the correlation between certain wood species and the crop being dried. As demonstrated in Chapter 5 **(Section 5.5)**, the use of Maloideae wood species is more likely to be found with a barley crop than oat or wheat. Hazel is found to co-occur more with wheat and oak with oat. This trend is particularly noticeable from pre-tenth century kilns, compared to post-tenth century features, where the wood variance among crops became less apparent. This is most probably as a result of the oak dominance found in most kilns from this period, a trend that is obscuring the role of other wood taxa at this time.

To understand the crop drying process in Ireland it is important to recognise that harvesting times could be quite variable prior to the introduction of pesticides and the use of modern mechanical techniques (Flynn 1996, 43). In his *Travels in Ireland* Johann Georg Kohl, commented on the slowness of grain to ripen in Ireland. When the summer was cold and wet, the wheat was frequently not cut till the middle of October and the oats in November (Kohl 1844, 43). Indeed oat was often harvested even later, according to an account from Co. Armagh in 1817; 'the grain was not reaped in many places until after Christmas' (Evans 1942, 100).

Barley requires more moisture than wheat and would need to be left longer to fully mature (Bell and Watson 2008). If cut too early however, the grain suffered, but left too long it was in danger of overheating making the stalks brittle and the heads break off (Doyle 1844, 44, 280). Wheat and oat are more vulnerable to high winds and heavy rains and grains can be lost if shaken, a problem made worse by a late harvest (Bell and Watson 2008, 180). In a dry season, failure to cut wheat and oats within eight to ten days of ripening could result in heavy losses while in a wet season irreversible grain-wetting was likely to occur if cutting was left too long (Collins 1969, 465).

There are references to summer reaping of wheat, particularly if the summer is hot and dry, the wheat harvest will be brought in as early as late July (O'Kelly 1997, 237). One reference to this from the thirteenth century alludes to this practice:

Annals of the Four Masters (O'Donovan 1860)   M1252:9

Great heat and drought prevailed in this Summer, so that people crossed the beds of the principal rivers of Ireland with dry feet. The reaping of the corn crops of Ireland was going on twenty days before Lammas the 1st of August, and the trees were scorched by the heat of the sun

Another annalistic account contains an unprecedented reference to a very late harvest in 1225:

Annals of Connacht (author unknown)   Annal 1225: 1225.37

The corn was being reaped after St. Bridget's Day and plowing [was going on] at the same time

(http://celt.ucc.ie/published/T100011/index.html; Accessed July 7, 2017)

This earlier harvest also coincides with major assemblies and festivals documented in the early sources, such as the óenach, (Meyer 1906b, Binchy 1958, Gleeson 2015) and the festival of Lugnasad both held at the beginning of August ((MacNeill 1962). Lughnasa marked the end of summer and the beginning of the harvest season, and on that day the first meal of the year's new food crop was eaten (MacNeill, 1962). Evidence for charred crops have been found on sites classified as possible óenach sites and may represent evidence for periodic feasting associated with these assemblies (Gleeson 2015, 35).

Threshing was done as soon as the harvest was finished and drying the grain commenced thereafter (Sigaut 1988, 7, 21) so the length of time between reaping and drying was relatively short. Crop drying was therefore a seasonal activity, and it was possible that one cereal variety may have needed drying if it matured a few weeks earlier or later than another (Sigaut 1988, 7).

Just where in the sequence the drying is applied is dependent very much on local conditions and processing techniques of the different grains (Gauldie 1981). Hulled grains (barley or glume wheats) also required additional threshing while oat needed to be dried at higher temperatures to make it more durable for storage and transport (Watson and Moore, 1962). So while the historical and ethnographical record depicts a picture of local variance in techniques, it is apparent that barley, oat and wheat can be subject to different threshing and drying requirements. Barley needs more threshing and if necessary, may be dried earlier or later, while oat needs less crop processing but demands a higher intensity of heat.

The high values for fruitwood species could suggest smoking grain for malting, particularly as the apple and cherry wood types impart a mild aromatic scent when burnt. To achieve this, the wood would have to be used shortly after fruit trees were pruned to take advantage of the fresh wood scent. While there are no explicit references to smoking grain during the early medieval in Ireland (Susan Flavin pers comm.), there is some mention of beer being brewed to foreign recipes (Meyer 1994). Archaeological evidence from Late Iron Age and medieval Germany do give insights into the range of crops and wild taxa that were used in malting, however, the types of wood used in the flavouring process is unknown (Stika 2011).

A more pragmatic alternative for the presence of fruitwood species with barley could reflect harvesting practices during this time. Apple and cherry wood would require pruning to keep annual fruit yields high, which was done after September when sap levels are lower and the fruit has been collected. Higher values for Maloideae (fruitwood) and cherry could represent the remains of cuttings from such activities at the same time as the barley grain is being dried on site, indicating that barley, for the most part was being harvested later than wheat and oat i.e. September or onwards. Kiln dating to pre-tenth century AD show Maloideae woods to be strong indicators of barley dominated kilns. Since barley requires more moisture than wheat and would need to be left longer to fully mature (Doyle, 1844, 44, 280) it may have been harvested later.

Wheat and oat are more vulnerable to high winds and heavy rains and grains can be lost if shaken, a problem made worse by a late harvest (Bell and Watson, 2008, 180), so reaping may have been done earlier, as attested by various documentary sources. Since wheat is strongly correlated with hazel and blackthorn, and oat with oak, all species shown to be associated with structural and fencing activities from this study, it seems likely that wheat and oat drying was closely linked with periods of construction/repair work, fencing or manufacturing on a site. This could reflect that building and repairs were carried out in late summer, producing offcuts and waste debris for fuelling the kiln at a time when the earliest harvests of wheat were ready to be dried.

It has already been demonstrated that pre-tenth century kilns and structural features, where craft and manufacturing were centralised, show significant similarities and have been interpreted as reflecting the varying changes to wood used in house building/repair or manufacture at a site. The correlation of oak with oat is interesting as this is trend that is seen in both early and later kiln activity. While variance in the wood matrix for drying oat is evident, oak is proportionally higher in kilns containing a dominant oat crop. Choosing oak over other woods to dry oat may be more intentional than expected. Oat has tightly fitted hulls, difficult to remove by threshing alone, and would have required drying at high temperatures to separate the outer husks from the whole grain to produce a palatable and finely ground meal (Monk, pers comm.).

Considering that oat was one of the mainstays in food production at this time (porridge, pottage, stews, flat oatencakes) (Sexton 1998, 76-86) and was a characteristic of a growing market economy during the later medieval period (Murphy and Potterton 2010, 313) it would have been necessary to fully process and de-husk this crop for food production. The use of oak wood and charcoal would have therefore provided the best fuel to ensure high kiln temperatures to successfully remove husks from the oat grain, particularly if this crop was used for human consumption. Since oak resource use was more prudent and selective during the early medieval period (pre-tenth century) its presence in kilns where oat was being dried is significant and may suggest a deliberate wood selection closely related to rigorous crop processing procedures.

Comparing the charcoal data to dominant crops in corn drying kilns has not only confirmed the strong correlation between on-site activities (building, craft, manufacture) and kiln fuel from the pre-tenth century period, but has provided potentially new information on seasonal activities coinciding with the crop harvest at a site during this time. Construction work in the form of house and fence building/repair and manufacture may have been carried out in late summer at a time when wheat and perhaps oats were being harvested, processed and dried. Other activities, such as pruning or cutting back fruit trees, are typically undertaken from September onwards, with haws ripening as late as October. This would correspond with the later barley harvest, strongly implying that potentially two phases of crop harvesting were being undertaken from late July to September/October, with drying occurring not long after. Long harvest seasons were not unusual in Ireland based on our mild but damp climate and ethnographic evidence has documented the harvest as running from late summer to the edge of winter (Evans, 1957, 151). Changes in on-site activities would certainly help to explain the opposing uses of hazel/blackthorn/oak (construction/fencing/manufacturing) and Maloideae/*Prunus* wood species (pruning) from medieval kiln activity.

If this model is to be considered then the charcoal assemblages from corn drying kilns are not just strongly linked to on-site activities but seasonal domestic and industrial events and can potentially reflect changes to the nature of those activities over time based on the variance of wood species identified. Through systematically analysing the wood charcoal from these features, in line with contemporary structural activities and where possible the macrofossil record, corn drying kilns are well placed to be used as a predictive or explanatory model for how local wood resources were used more broadly and any variations in use that may have occurred. In addition, if fruitwood species in kiln deposits are now recognised as reflecting a seasonal event associated with pruning, this provides new and valuable information on the nature of medieval orchards or gardens and how they were managed.

To date archaeology has not provided much evidence for rural gardens/orchards with the exception of identifying field systems (Corlett and Potterton 2009) or monastic gardens (Reeves-Smyth and Hamond 1983). Interestingly, gardens and kilns are documented as being found in the *airlise*, the area outside the enclosed farmstead or *les* (O'Kelly 1997, 369). This helps to strengthen the presence of fruitwood species as part of a garden within an enclosed settlement complex with the practical application of managing these trees reflected in kiln maintenance. The analyses of kiln charcoal assemblages, in the context of enclosed sites can therefore offer new insights into medieval garden archaeology to help redefine or re-evaluate the nature and layout of rural medieval settlements and the activities therein.

6.6 Relevance of the research and concluding remarks

This research has made a valuable contribution to the use and application of archaeological charcoal data specifically for the medieval period in Ireland, by providing new insights into wood resource use, woodland dynamics and the human response to a changing physical and socio-political landscape during this time. This study has generated the largest charcoal dataset for medieval Ireland to date from which future research agendas can be based and built upon.

During the course of this study, the methodology used has not only supported and improved the existing quantitative analysis and sampling procedures for charcoal datasets in an Irish context, but has developed a more refined approach to analysing charcoal assemblages from medieval archaeological features.

The use of rigorous statistical analysis not only reinforced the patterns observed through the standard quantitative approaches, but emphasised other pertinent trends in the data that were not so apparent - that oak use or its presence in features is distinctively different from other taxa particularly between the late seventh and late ninth/tenth century AD; the role of ash as a possible substitute for oak during times of an oak reduction; the poor correlation between woods used in construction/manufacturing works (oak, ash, hazel, willow and blackthorn) and fruitwood species (Maloideae and *Prunus* species) and how the presence of these wood taxa in corn drying kilns, supported by a novel approach in using comparative plant macrofossil data, strongly suggests seasonal activities at site level, evidence for which is still under-researched in the archaeological record.

Upon reflection, the large charcoal dataset analysed was necessary to establish intimate details of context-related variation and how features were associated with each other, which ultimately formulated the foundations for many of the arguments put forward in this thesis. The role of oak as a resource is better understood and the nature of its existence and management in the early medieval landscape redefined, which in turn has helped to explain and understand other strands of archaeological and historical evidence with regard to changes in wood selection and woodland management strategies in response to oak as a diminishing or unavailable raw material between the late seventh and late ninth/tenth century AD. The rise in oak use from the tenth century and later periods has also been more critically assessed and while samples from this period remain under-represented compared to the early medieval period, viable hypotheses explaining this later oak dominance have been put forward.

Fundamental to understanding these results in context are corn drying kilns. Through the kiln charcoal and plant macrofossil datasets, these features intimately reflect the changes in variance and abundance of wood resource use at site level. Prior to the late ninth/tenth century, the wood used to fuel corn drying kilns was closely connected to the rhythm and continuity of wood change that existed through construction, fencing, craft and manufacturing activities being carried out on site. Wood selectivity was low as it represented the waste debris and offcuts being recycled as fuel. Wood used to fuel corn drying kilns was therefore not an important component in how they functioned, instead the availability of a wood source dictated fuel supply, which was accommodated by other on-site activities. These results are supported by studies on fuel management strategies, which show that when suitable wood resources are unavailable, there will be more diversity in the wood composition as selectivity is lower. This compares to a high selectivity scenario where a single dominant species (e.g. oak) represents the preferred fuel choice and as such reflects the periods when it can be found in more abundance at a site.

The picture presented after the tenth century upon an appraisal of other archaeological and historical evidence is more obscure. The dominance of oak in kilns now reflects a more managed scenario, where oak seems to be prioritised for specialised activities (e.g. metalworking, charcoal production and ship building). Other wood taxa are generally under-represented and as such it is difficult to fully establish their role in the latter part of the early medieval and later medieval settlement economy.

This research then considers kilns to be used as a viable proxy for shifts in wood use and in turn the human response to changes to local woodland through periods of clearance, regeneration and management during the medieval period. In addition, the use of Bayesian chronological modelling for interpreting context-related activity is a novel and exploratory venture for these datasets, an application that is currently under-utilised for the medieval period. By implementing this technique using the kiln charcoal dataset, new estimates for dating key changes to wood resource use have been proposed, which coincides with major socio-economic shifts in the political landscape during the medieval period. This nuance approach therefore offers a new and innovative way to refine medieval chronologies using the archaeological record.

Finally, while charcoal is proving to be a valuable tool in understanding medieval woodland resource use, results are largely culturally driven and it is accepted that caution be used when interpreting patterns of arboreal reconstructions using this method. Instead the use of this data has contributed to understanding and explaining the anthropogenic factors that influenced woodland change and wood selection during this period. To date, charcoal studies in both Ireland and abroad are largely concerned with woodland reconstruction particularly for the prehistoric period. Few are used for interpreting the medieval period and as such the subject of wood use and woodland change is still very much driven by historical and documentary evidence. This project has shown that while a multi-disciplinary approach is necessary to elucidate the current debates on medieval woodland ecology and human activity, the use of charcoal challenges the results of existing applications and offers new ways to approach medieval woodland studies using the archaeological record.

6.7 Future work

This study primarily focused on a landscape that had a similar geographical, topographical, archaeological and historical background as a means of providing new insights into wood use during the medieval period in Ireland using the archaeological charcoal record. This has produced a viable framework where key components in the dataset can be confidently used as markers in explaining woodland resource use and change over time at site level, including new ways to investigate seasonality in the archaeological record. The research questions and outcomes examined by this thesis should be extended to include more charcoal data from other regions in Ireland to allow for a more comparative assessment to take place. This would help with further identifying if the patterns of wood use observed were consistent throughout the medieval Irish landscape or regionally scattered.

While this project has presented new hypotheses for explaining changes in wood resource by engaging with the historical record and other forms of archaeological and palaeoecological evidence, it does so more broadly. Considering the diversity of local politics within regional dynasties, it was not within the scope of this research to discuss the results based on the intricacies of the historical record, of which there is much regional disparity. This avenue of research however, would be very useful in understanding further the socio-political background to individual medieval settlements and landscapes, which may help to explain the anthropogenic factors that influenced wood use at certain sites and if certain sites were socially or economically distinct from each other.

In addition, sites containing a dominant oak charcoal assemblage e.g. Twomileborris, Co. Tipperary (others include Johnstown and Parknahown 5, Co. Meath; Ballybrowney Lower, Co. Cork) are worth further historical investigation to help understand the nature of these sites which may provide insights into the preponderance of oak use in these locations – are they situated close to or associated with known high status settlement; considering the artefactual evidence, do they facilitate specialised activities pertaining to a high status economy; are they located close to or on known rivers or watercourses for transportation and importation; what is the level of metalworking being carried out and are these sites close to areas for bog-ore extraction. A geographical survey (GIS) of these early medieval settlement sites based on their wood resource use could explain the context of wood variability from site to site, which may help define or differentiate consumer from producer sites at local and regional level. In turn, this could provide a workable model to help further classify rural medieval settlements and the landscapes they were situated in.

While this study endeavoured to seek ways to differentiate structural wood from fuel wood from the corn drying kiln charcoal dataset, it proved difficult as not all components of each kiln (fire-pit/flue/chamber) were sampled separately or indeed survived *in situ.* Now that a working framework of understanding the charcoal remains from kilns has been established, the next step would be to use this material to tease out the burnt remains of kiln fabric and furniture from the wood used to fuel these features. The three main features of a kiln should be strategically targeted and compared and, where possible young roundwoods should be analysed further for evidence of coppicing (wattling). Experimental archaeology would help to understand the inner workings of the kiln to ascertain how aerodynamics affected the burning of the wood, its survival by taxon and the role of taphonomy in this context.

To further investigate seasonality on a broader scale using the charcoal record, a comprehensive review of corn drying kiln charcoal and plant macrofossil data together should be undertaken. By comparing the results regionally, this model has the potential to establish if through variation in wood resource use, changes were occurring in crop harvest regimes particularly during the early medieval period. As demonstrated through this thesis, these subtle details provide a new approach to understanding arable practices by highlighting early and late harvest seasons. Considering the well documented climatic oscillations that were occurring during this period, recursive or variable trends in the datasets may help to offer insights into whether harvest practices were driven or influenced by environmental or anthropogenic factors.

The use of Bayesian chronological modelling on the corn drying kiln dataset provided a novel way to refine the dating parameters for when major changes in wood resource use occurred. This approach has in turn produced plausible posterior dates for when early medieval settlement/rath construction commenced and went into decline. It is well known through the pollen analysis that woodland clearance for early medieval settlement and agriculture was not synchronise across Ireland, this technique therefore offers a way to potentially chart when woodland clearance defining early medieval activity commenced in different regions of Ireland. By grouping and collating corn drying kiln data from each county or townland together, this approach has the potential to produce a range of posterior density estimates that can be used to chart where and when the earliest early medieval woodland clearances began, how this compared on a local or regional basis and how long this transition took place. Corn drying kilns are one of the most radiocarbon dated features in the Irish archaeological record, if not the most dated and with markers of wood change now highlighted through the charcoal dataset, this new method of dating the start and end of major events would revolutionise and significantly transform how archaeological sites are dated and how quickly new ideas and technological advances diffused across the landscape of medieval Ireland.

To establish if the charcoal remains represent pre-made charcoal or the burning of seasoned/fresh wood, more analytical work is required in this under-researched area. The use of experimental archaeology would go some way to elucidate this and with the vast charcoal data already collated from charcoal production pits, kilns and metalworking features, there exists a suitable body of archaeological material for comparative studies. It would be particularly interesting to compare pre-late eighth/early ninth century AD and post-ninth/tenth century AD charcoal assemblages from corn drying kiln and metalworking features, as this was when it has been proposed that more stringent woodland management practices were being employed more broadly. While still a new and exploratory tool, the use of reflectance analysis, which measures burning temperatures on oak charcoal remains, has the potential to offer new ways to differentiate burning wood and burning charcoal. This type of micro analysis would help with further investigating the level and extent of medieval wood resource management on a site by site and feature by feature basis.

This project extends beyond its primary objectives and opens up a range of different facets to explore further charcoal analysis on a more micro level; adds significant value to palaeoecological and palaeoclimatic studies in the area of woodland reconstruction and the impact of environmental change to trees, woods and wooded landscapes and by contributing to research in areas of medieval woodland management, seasonality, past human behaviour and wood resource use, emphasises the importance of merging environmental archaeological datasets with the archaeological and historical record.

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Appendices

Appendix 1 List of sites analysed as part of this study

Appendix 2 List of all contexts and samples analysed by site

Appendix 3 List of all wood taxa identifications by site

Appendix 4 List of all radiocarbon dates (AMS) by site

Appendix 1. List of sites analysed (N9/N10 Co. Kilkenny, N8/M8 Co. Tipperary and Toureeen Peckaun, Co. Tipperary)

County	Townland	Site Code	NMS No.	Easting	Northing	ITM Easting	ITM Northing	Site type	Period	RMP's recorded (<500m)	Archaeology Company	Licence holder	Charcoal analyst	Site reference
Carlow	Monanduff	AR137 Site 1	E3839	267261	164397	667196.8278	664438.714	Pits	Early medieval	N/A	IAC Ltd	Rob Lynch	Susan Lyons	Lynch, R and Coughlan, T 2012a N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Moanduff AR137
Carlow	Moanduff	AR155 Site 2	E3735	267372	164454	667307.8036	664495.701	Pits	Iron Age/Early medieval transition	N/A	IAC Ltd	Rob Lynch	Susan Lyons	Lynch, R and Coughlan, T 2012b N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Moanduff AR155
Carlow	Coneykeare	AR138 Site 1	E3683	267836	166209	667771.7047	666250.316	Enclosed settlement & production	Early medieval	Enclosure at Ballknowckan CW012-068; Monastic site at Old Leighlin CW011-016	IAC Ltd	Sinead Phelan	Susan Lyons	Phelan, S and Coughlan, T 2012 N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Coneykeare AR138
Kilkenny	Baysrath	AR055	E3627	251593	137855	651532.2489	637902.554	Settlement & Production	Early medieval	Ringforts KK031-006/013. Moated site KK031-050. Ecclesiastical remains KK031-015. Deserted settlement KK031-012. Castle site KK031-014	IAC Ltd	Fintan Walsh	Susan Lyons	Walsh, F 2013 N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Baysrath AR055
Kilkenny	Baysrath	AR53/54	E2517	251596, 251622, 251630, 251623	137629, 137647, 137692, 137732	651535.2484	637676.604	Settlement complex/ cemetery	Early medieval	Enclosure KK031-013	VJK Ltd	John Channing	Ellen OCarroll	Channing, J. 2012 N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny: Baysrath AR053/54
Kilkenny	Tinvaun	AR066 Site 3	E3606	251508	139917	651447.2664	639964.105	Pits	Late medieval	Ringfort KK031-006. Moated site KK031-050	IAC Ltd	James Kyle	Susan Lyons	Kyle, J and Coughlan, T 2011 N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Tinvaun AR066
Kilkenny	Knockadrina	AR068	E36111	251631	140245	651570.2394	640292.033	Settlement	Early medieval	Ringfort KK031-006. Enclosure KK031-012001. Moated site KK031-050	IAC Ltd	Ed Lyne	Susan Lyons	Kyle, J., 2011 N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Knockadrina AR068

County	Townland	Site Code	NMS No.	Easting	Northing	ITM Easting	ITM Northing	Site type	Period	RMP's recorded (<500m)	Archaeology Company	Licence holder	Charcoal analyst	Site reference
Kilkenny	Kellsgrange	AR073 Site 3	E3576	250948	144003	650887.3876	644049.215	Industrial & Production	Early medieval	Castle KK027-018. Enclosures KK027-007/034/032	IAC Ltd	James Kyle	Susan Lyons	Kyle, J and Coughlan, T 2011 N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Kellsgrange AR073
Kilkenny	Holdenstown	AR096 Site 1	E3681	256737	151253	656675.1217	651297.617	Industrial & Production	Early medieval	Ringfort KK020-054; 014. Enclosures KK020-051/053; KK024-017-019/021	IAC Ltd	Yvonne Whitty	Susan Lyons	Whitty, Y., 2013 N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Holdenstown Site 1 AR096
Kilkenny	Holdenstown	AR098 Site 2	E3630	256891	151781	656829.0882	651825.501	Settlement & Production	Early medieval	Ringfort KK020-054; 014. Enclosures KK020-051/053; KK024-017-019/021	IAC Ltd	Yvonne Whitty	Susan Lyons	Devine, E and Coughlan, T 2013a N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Holdenstown Site 2 AR098
Kilkenny	Danesfort	AR082 Site 5	E3456	252650	147803	652589.0154	647848.382	Settlement & Production	Early medieval	Ringforts KK023-057/058; Field system KK023-060; Enclosures KK023-061/082	IAC Ltd	Emma Devine	Susan Lyons	Devine, E and Coughlan, T 2013b N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Danesfort AR083
Kilnenny	Danesfort	AR083 Site 6	E3538	252764	147995	652702.9905	648040.339	Settlement	Late medieval	Ringforts KK023-057/058; Field system KK023-060; Enclosures KK023-061/082	IAC Ltd	Emma Devine	Ellen OCarroll	Devine, E and Coughlan, T 2013c N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Danesfort AR083
Kilkenny	Kilree	AR093 Site 3	E3643	254449	149639	654387.6221	649683.976	Settlement & burial	Early medieval	Enclosures KK023-048001; 049001-03; KK023-061/02; KK024-032; 058. Deserted medieval settlement KK023-047001. Castle/Towerhouse KK023-047001	IAC Ltd	Patricia Lynch	Susan Lyons	Devine, E and Coughlan, T 2013d N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Kilree Site 3 AR093

County	Townland	Site Code	NMS No.	Easting	Northing	ITM Easting	ITM Northing	Site type	Period	RMP's recorded (<500m)	Archaeology Company	Licence holder	Charcoal analyst	Site reference
Kilkenny	Kilree	AR094 Site 4	E3730	255330	150084	655268.4294	650128.876	Settlement & Production	Early medieval	Enclosures KK023-048001; 049001-03; KK023-061/02; KK024-032; 058. Deserted medieval settlement KK023-047001. Castle/Towerhouse KK023-047001	IAC Ltd	Patricia Lynch	Susan Lyons	Lynch , P., 2013 N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Kilree Site 4 AR094
Kilkenny	Templemartin	AR152	E3849	254504	155826	654442.6131	655869.627	Industrial & Production	Late Iron Age/Early Medieval Transition	Enclosures KK020-008; 029; 03001-2; KK019-033; 036. Holy well KK020-010; Castle KK020-027; 032	IAC Ltd	Emma Devine	Susan Lyons	Devine, E and Coughlan, T 2011 N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Templemartin AR152
Kilkenny	Jordanstown	AR120 Site 2	E3851	264893	159038	664829.3401	659080.891	Industrial	Early medieval	Ecclesiastical enclosure KK021-001003; Enclosures KK021-002001-003; Souterrain KK016-009001	IAC Ltd	James Kyle	Susan Lyons	Lyne E and Coughlan, T 2012 N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Jordanstown AR120
Kilkenny	Shankill	AR128 Site 2	E3738	265924	160651	665860.1158	660693.536	Settlement	Late medieval	N/A	IAC Ltd	Richard Jennings	Susan Lyons	Jennings R., 2013a N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Shankill AR128
Kilkenny	Shankill	AR131 Site 5	E3850	266374	166209	666310.0251	666250.322	Settlement	Late medieval	N/A	IAC Ltd	Richard Jennings	Susan Lyons	Jennings R., 2013b N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Shankill AR31
Kilkenny	Leggetsrath East	AR154 Site 1	E3734	253793	156484	653731.7692	656527.486	Enclosed settlement	Early medieval	N/A	IAC Ltd	Emma Devine	Susan Lyons	Devine, E and Coughlan, T 2013e N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Leggetsrath East AR154
Kilkenny	Kellymount	AR032 Site 5	E3858	265530	159977	665466.2014	660019.684	Ditch	Early medieval	N/A	IAC Ltd	Przemaslaw Wierbicki	Susan Lyons	Przemaslaw, W., 2010 N9/N10 Kilcullen to Waterford Scheme: Phase 4 Knocktopher to Powerstown. Final Report for Kellysmount AR127

County	Townland	Site Code	NMS No.	Easting	Northing	ITM Easting	ITM Northing	Site type	Period	RMP's recorded (<500m)	Archaeology Company	Licence holder	Charcoal analyst	Site reference
Kilkenny	Milltown	AR003-005	E2499	AR03: 258621 AR04: 258607 AR05: 258642	AR03: 117998 AR04: 118078 AR05:118112	658544.7448	618129.859	Industrial & Production	Early medieval	N/A	VJK Ltd	Joanna Wren	Ellen OCarroll	Wren, J 2010a N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny: Milltown AR03-05
Kilkenny	Ballykeoghan	AR010-012	E2501	AR10: 258444 AR11: 258408 AR12: 258291/258260	AR10: 118935 AR11:119016 AR12: 119229/119288	658345.7861	619067.654	Industrial & Production	Early medieval	N/A	VJK Ltd	Joanna Wren	Ellen OCarroll	Wren, J 2010b N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny: Ballykeoghan AR10-12
Kilkenny	Scart and Rahard	AR019	E2504	256887	121806	656825.1126	621857.047	Industrial & Production	Late medieval	Ringforts KK040-069	VJK Ltd	Jonathan Monteith	Ellen OCarroll	Monteith, J 2010a N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny: Scart and Rahard AR019
Kilkenny	Scart	AR020	E2505	256788	122394	656726.133	622444.919	Industrial & Production	Early medieval	Ringforts KK040-069; KK040-05201; KK040-05202	VJK Ltd	Jonathan Monteith	Ellen OCarroll	Monteith, J 2010b N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny: Scart AR020
Kilkenny	Coolmore	AR044	E3015	251987	133332	651926.1664	633380.541	Kilns	Later medieval	N/A	VJK Ltd	Jonathan Monteith	Ellen OCarroll	Monteith, J 2010c N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny: Coolmore AR044
Kilkenny	Ricesland	AR01	08E135	252233	137418	652172.1093	637465.648	Charcoal production	Late medieval	Knocktopher village KK031-017	VJK Ltd	Medh Grant	Ellen OCarroll	Grant, M., 2010 N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny: Riceland AR01
Kilkenny	Earlsrath	AR30	E2510	256464	125517	656402.1981	625567.236	Enclosed settlement	Early medieval	N/A	VJK Ltd	Liam McKinstry	Ellen OCarroll	McKinstry, L. 2010a N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny: Earlsrath AR030
Kilkenny	Earlsrath	AR33	E3007	256305	127233	656243.2301	627282.862	Ditch; Settlement?	Late medieval	Moated site KK036-032	VJK Ltd	Liam McKinstry	Ellen OCarroll	McKinstry, L. 2010b N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny: Earlsrath AR033
Kilkenny	Earlsrath & Ballylusky	UTA4	E3645	256400	126388	656338.2106	626438.046	Metalworking pits	Early medieval	N/A	VJK Ltd	Joanna Wren	Ellen OCarroll	Wren, J 2010c N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny:Earlsrath/Ballylusky UTA4

County	Townland	Site Code	NMS No.	Easting	Northing	ITM Easting	ITM Northing	Site type	Period	RMP's recorded (<500m)	Archaeology Company	Licence holder	Charcoal analyst	Site reference
Kilkenny	Rahard West	AR017-18	E2503	257150	121178	657088.0564	621229.184	Ditches, linear, hearth	Early medieval	Ringforts KK949-064; KK040-065	VJK Ltd	Graeme Laidlaw	Ellen OCarroll	Laidlaw, G., 2010 N9/N10 Kilcullen to Waterford Scheme:Waterford to Knocktopher – Phase 2 Archaeological Resolution Dunkitt to Sheepstown, Co. Kilkenny: Rahard West AR017-18
Tipperary	Gortmakellis	AR001	E2356	209031	143429	608979.5157	643475.469	Enclosure complex adjacent to TS61-003	Early medieval	Ringfort TS61-003	VJK Ltd	Paul Stevens	Susan Lyons	Moore, E, Stevens, P, Baker, L & Green, B 2009 'M8/N8 Cullahill to Cashel Road Improvement Scheme: Final Archaeological Report E2365 Site AR1, Gortmakellis, Co. Tipperary'
Tipperary	Moycarkey	AR012	E2365	214710	151664	614657.2903	651708.662	Isolated pits	Early medieval	Ringfort TN047-70	VJK Ltd	Paul Stevens	Ellen OCarroll	McCullough, DA, Breen, T, Stevens, & Green, B 2009a 'M8/N8 Cullahill to Cashel Road Improvement Scheme: Final Archaeological Report E2365 Site AR12, Moycarkey, Co. Tipperary'
Tipperary	Moycarkey	AR013	E2366	214823	151843	614770.266	651887.623	Pits	Early medieval	Ringfort TN047-70	VJK Ltd	Paul Stevens	Ellen OCarroll	McCullough, DA, Breen, T, Stevens, & Green, B 2009b 'M8/N8 Cullahill to Cashel Road Improvement Scheme: Final Archaeological Report E2366 Site AR13, Moycarkey, Co. Tipperary'
Tipperary	Moycarkey	AR015	E2367	219401	152005	619347.2702	652049.573	Pits	Late medieval	Ringfort TN047-70	VJK Ltd	Paul Stevens	Ellen OCarroll	McCullough, DA, Breen, T, Stevens, P & Green, B 2009c 'M8/N8 Cullahill to Cashel Road Improvement Scheme: Final Archaeological Report E2367 Site AR15, Moycarkey, Co. Tipperary'
Tipperary	Ballydavid	AR026	E2370	216948	155265	616894.8077	655308.873	Settlement; TN048:005	Early medieval	Ringfort TN048-005	VJK Ltd	Paul Stevens	Ellen OCarroll	Hardy, C, Stevens, P & Green, B 2009 'M8/N8 Cullahill to Cashel Road Improvement Scheme: Final Archaeological Report E2370 Site AR26, Ballydavid, Co. Tipperary'
Tipperary	Blackcastle & Borris	AR031	E2374	219123, 219385	157755, 157642	619331.2801	657685.348	Production	Late medieval	Medieval settlement TN042-052	VJK Ltd	Mick O'Droma	Susan Lyons	Stevens, P 2010 'M8/N8 Cullahill to Cashel Road Improvement Scheme: Final Archaeological Report E2374 Site AR31, Borris and Blackcastle, Co. Tipperary'

County	Townland	Site Code	NMS No.	Easting	Northing	ITM Easting	ITM Northing	Site type	Period	RMP's recorded (<500m)	Archaeology Company	Licence holder	Charcoal analyst	Site reference
Tipperary	Borris	AR033	E2376	219538	157497	619484.2466	657540.379	Enclosure complex	Multi-period; Early medieval	Ringfort TN042-052005; Castle/towerhouse TN042-052001; Church TN042-052002; Castle/ringwork TN042-052003; Watermill TN042-052005; Moated site TN042-053; Deserted village TN042-052	VJK Ltd	Mick O'Droma	Susan Lyons	Stevens, P and O'Droma, M., .2010 'M8/N8 Cullahill to Cashel Road Improvement Scheme: Final Archaeological Report E2376 Site AR33, Borris, Co. Tipperary'
Tipperary	Monadreela	Site 5	03E0299	209671	142011	609619.3755	642057.775	Kiln	Early medieval	Ballyknock hill enclosures TS061-008; TS061-009; TS061-010	JCNA Ltd	Neil O'Flana	Susan Lyons	O'Brien, R 2014 'N8 Cashel Bypass & N74 Link Road Phase 2 Archaeological Investigations: Site 5 Monadreela (03E0299) Final Report
Tipperary	Monadreela	Site 8	03E0379	209656	141868	609604.3786	641914.806	Enclosed settlement associated with Monadreela Sites 9, 11 and 12	High/Late medieval	Moated site at Boscabell TS061-027	JCNA Ltd	Neil O'Flana	Susan Lyons	O'Brien, R and O'Droma M 2014a 'N8 Cashel Bypass & N74 Link Road Phase 2 Archaeological Investigations: Site8 Monadreela (03E0379) Final Report
Tipperary	Monadreela	Site 9	03E0345	209652	141837	609600.3795	641883.813	Enclosed settlement associated with Monadreela Sites 8, 11 and 12	High/Late medieval	Moated site at Boscabell TS061-027 and Killistafford TS061-030	JCNA Ltd	Neil O'Flana	Susan Lyons	O'Brien, R and O'Droma M 2014b 'N8 Cashel Bypass & N74 Link Road: Phase 2 Archaeological Investigations: Site 9 Monadreela (03E0345) Final Report
Tipperary	Monadreela	Site 11	03E0346	209654	141772	609602.379	641818.827	Enclosed settlement associated with Monadreela Sites 8, 9 and 12	Early & Late medieval	Moated site at Boscabell TS061-027	JCNA Ltd	Neil O'Flana	Susan Lyons	O'Brien, R and O'Droma M 2014c 'N8 Cashel Bypass & N74 Link Road: Phase 2 Archaeological Investigations: Site 11 Monadreela (03E0346) Final Report
Tipperary	Monadreela	Site 12	03E0393	209630	141683	609578.3841	641729.847	Boundary ditch/pit assoc. with Monadreela Sites 8, 9 and 11	Late medieval	Moated site at Boscabell TS061-027	JCNA Ltd	Joanne Hugh	Susan Lyons	O'Brien, R and O'Droma M 2014d 'N8 Cashel Bypass & N74 Link Road: Phase 2 Archaeological Investigations: Site 12 Monadreela (03E0393) Final Report

County	Townland	Site Code	NMS No.	Easting	Northing	ITM Easting	ITM Northing	Site type	Period	RMP's recorded (<500m)	Archaeology Company	Licence holder	Charcoal analyst	Site reference
Tipperary	Boscabell	Site 19	03E0426	209655	141350	609603.3784	641396.919	Enclosed settlement	High/Late medieval	Ringforts TS061-028; TS061-029. Moated site at Boscabell TS061-027	JCNA Ltd	John Kavanagh	Susan Lyons	O'Brien, R and O'Droma M 2014e 'N8 Cashel Bypass & N74 Link Road Phase 2 Archaeological Investigations: Site 19 Boscabell (03E0426)
Tipperary	Boscabell	Site 20	03E0470	209359	141147	609307.4424	641193.964	Enclosed settlement	Early medieval	Ringforts TS061-028; TS061-029. Moated site at Boscabell TS061-027	JCNA Ltd	John Kavanagh	Susan Lyons	O'Brien, R and O'Droma M 2014f 'N8 Cashel Bypass & N74 Link Road: Phase 2 Archaeological Investigations: Site 20 Boscabell (03E0470) Final Report
Tipperary	Hughes-Lot East	Site 25ii	03E0730	209380	140607	609328.4374	640654.081	Double-enclosed settlement associated with Hughes' Lot E 25iii/iv	Early medieval	Enclosures TS061-132001; TS061-132002	JCNA Ltd	Joanne Hughes	Susan Lyons	O'Brien, R and O'Droma M 2014g 'N8 Cashel Bypass & N74 Link Road: Phase 2 Archaeological Investigations: Site 25ii Hughes Lot East (03E0730) Final Report
Tipperary	Hughes-Lot East	Site 25iii	03E0746	209355	140457	609303.4427	640504.114	Ditch associated with Hughes' Lot E 25ii/iv	Early medieval	Enclosures TS061-132001; TS061-132002	JCNA Ltd	Joanne Hughes	Susan Lyons	O'Brien, R and O'Droma M 2014h 'N8 Cashel Bypass & N74 Link Road Phase 2 Archaeological Investigations: Site 25iii Hughes Lot East (03E0746) Final Report
Tipperary	Hughes-Lot East	Site 25iv	03E0807	209317	140363	609265.4509	640410.134	Enclosed settlement associated with Hughes' Lot E 25ii/iii	Early medieval	Enclosures TS061-132001; TS061-132002	JCNA Ltd	Joanne Hughes	Susan Lyons	O'Brien, R and O'Droma M 2014i 'N8 Cashel Bypass & N74 Link Road: Phase 2 Archaeological Investigations: Site 25iv Hughes Lot East (03E0807)
Tipperary	Farranamanagh	Site 39	03E0757	209581	142208	609529.3952	642254.733	Industrial	Early medieval	Enclosures TS060-081; TS060-099; TS060-144; Ringfort TS060-084; Moated sites TS060-082; TS060-086	JCNA Ltd	Neil O'Flanagan	Susan Lyons	O'Brien, R and O'Droma M 2014j 'N8 Cashel Bypass & N74 Link Road: Phase 2 Archaeological Investigations: Site 39 Farranamanagh (03E0757) Final Report
Tipperary	Windmill	Site 35	03E0424	207291	139059	607239.8892	639106.424	Series of pits and postholes	Medieval	Enclosure TS061-072; Ringfort TS060-108; Moated site TS061-167	JCNA Ltd	Neil Fairburn		O'Brien, R and O'Droma M 2014k 'N8 Cashel Bypass & N74 Link Road: Phase 2 Archaeological Investigations: Site 35 Windmill (03E0424) Final Report
Tipperary	Toureen Peckaun	-	05E0247	201245	128163	601195.1894	628212.812	Monastic	Early - Late medi	Church TS075-023001; Ecclesiastical enclosure TS075-023007	Tomás Ó'Carragáin (UCC)	Tomás O'Carragáin	Susan Lyons	Ó'Carragáin, T 2008 'Stratigraphic Report on archaeological excavations at Toureen Peckaun, Co. Tipperry (05E0247)' Unpublished site report

Appendix 2. List of all contexts and samples analysed (arranged by site)

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Gortmakellis AR01 E2356	19	157	153	Fill of kiln	1	12
Tipperary	Gortmakellis AR01 E2356	19	153	84	Upper fill of kiln	2	26
Tipperary	Gortmakellis AR01 E2356	103	104	36	Basal fill of bowl	2	44
Tipperary	Gortmakellis AR01 E2356	103	104	87	Basal fill of bowl	1	21
Tipperary	Gortmakellis AR01 E2356	101	102	197	Fill of raking pit	1	5
Tipperary	Gortmakellis AR01 E2356	101	123	57	Basal fill of raking pit	5	30
Tipperary	Gortmakellis AR01 E2356	101	122	58	Basal fill of raking pit	3	8
Tipperary	Gortmakellis AR01 E2356	101	125	76	Fill of raking pit	5	50
Tipperary	Gortmakellis AR01 E2356	118	119	412	Stone lining deposit	3	50
Tipperary	Gortmakellis AR01 E2356	118	119	413	Stone lining deposit	2	10
Tipperary	Gortmakellis AR01 E2356	409	405	391	Fill of flue	1	4
Tipperary	Gortmakellis AR01 E2356	188	57	14	Fill of ditch	1	4
Tipperary	Gortmakellis AR01 E2356	426	36	32	Fill of double ditch	1	2
Tipperary	Gortmakellis AR01 E2356	188	307	217	Fill of ditch	1	25
Tipperary	Gortmakellis AR01 E2356	88	76	348	Fill of enclosure ditch	1	3
Tipperary	Gortmakellis AR01 E2356	99	381	385	Fill of enclosure ditch	1	50
Tipperary	Gortmakellis AR01 E2356	228	227	135	Fill of central hearth	4	50
Tipperary	Gortmakellis AR01 E2356	21	127	81	Fill of burnt pit	2	50
Tipperary	Gortmakellis AR01 E2356	3	355	378	Basal fill of ditch	1	4
Tipperary	Gortmakellis AR01 E2356	172	171	95	Fill of posthole	1	3
Tipperary	Moycarkey AR12 E2365	2	11	4	Charcoal production pit	1	70
Tipperary	Moycarkey AR13 E2366	6	22	10	Fill of pit	2	65
Tipperary	Moycarkey AR13 E2366	41	40	19	Fill of pit	1	50
Tipperary	Moycarkey AR15 E2367	6	4	4	Fill of pit	2	65
Tipperary	Moycarkey AR15 E2367	9	16	6	Fill of pit	1	50
Tipperary	Ballydavid AR26 E2370	287	281	228	Fill of kiln	1	20
Tipperary	Ballydavid AR26 E2370	287	281	188	Fill of kiln	2	33
Tipperary	Ballydavid AR26 E2370	287	280	232	Fill of kiln	1	50
Tipperary	Ballydavid AR26 E2370	287	280	187	Fill of kiln	4	34
Tipperary	Ballydavid AR26 E2370	287	280	221	Fill of kiln	3	30
Tipperary	Ballydavid AR26 E2370	287	282	234	Fill of kiln	3	47
Tipperary	Borris Blackcastle AR31 E2374	91	99	95	Middle fill of kiln	1	100
Tipperary	Borris Blackcastle AR31 E2374	91	191	144	Basal fill of kiln	3	26
Tipperary	Borris Blackcastle AR31 E2374	306	308	183	Upper fill of pit	3	100
Tipperary	Borris Blackcastle AR31 E2374	292	562	302	Fill of metal working area	2	50

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Borris Blackcastle AR31 E2374	660	662	372	Basal fill of kiln	2	27
Tipperary	Borris Blackcastle AR31 E2374	697	820	437	Basal fill of kiln flue 697 (kiln 660)	1	6
Tipperary	Borris Blackcastle AR31 E2374	1021	1022	539	Single fill of ditch	4	50
Tipperary	Borris Blackcastle AR31 E2374	1440	1441	583	Single fill of ditch	4	50
Tipperary	Borris Blackcastle AR31 E2374	1758	1765	750	Middle fill of stone lined kiln	4	50
Tipperary	Borris Blackcastle AR31 E2374	2132	2133	756	Basal fill of ditch	5	50
Tipperary	Borris Blackcastle AR31 E2374	2132	2134	1070	Upper fill of ditch	6	97
Tipperary	Borris Blackcastle AR31 E2374	1758	2708	1020	Basal fill of stone lined kiln	2	50
Tipperary	Borris Blackcastle AR31 E2374	2043	2044	1039	Basal fill of metal working smithy	2	50
Tipperary	Borris Blackcastle AR31 E2374	3005	3356	1172	Clay walled structure	5	55
Tipperary	Borris AR33 E2376	-	679	304	Structure 1; Annex Enclosure A	4	91
Tipperary	Borris AR33 E2376	751	752	362	Single fill of wall slot of structure 2 in interior of enclosure A	3	22
Tipperary	Borris AR33 E2376	787	785	418	Single fill of wall slot of structure 1 in interior of enclosure A	0	0
Tipperary	Borris AR33 E2376	1398	1399	1066	Single fill of wall slot of structure 3 in interior of enclosure A	1	1
Tipperary	Borris AR33 E2376	2071	2074	1663	Middle fill of charcoal rich pit to north of enclosure A	3	16
Tipperary	Borris AR33 E2376	1145	1143	848	Middle fill of kiln C north of Enclosure A	0	0
Tipperary	Borris AR33 E2376	1145	1148	898	Lower fill of kiln C north of Enclosure A	3	95
Tipperary	Borris AR33 E2376	130	131	54	Single fill of smithing hearth cut into top of Enclosure B ditch	5	96
Tipperary	Borris AR33 E2376	1423	1416	1037	Single fill of wall slot of structure 5 in interior of enclosure B	4	46
Tipperary	Borris AR33 E2376	2015	2016	1599	Basal fill of roasting pit, interior Enclosure B	1	80
Tipperary	Borris AR33 E2376	2015	2023	1603	Middle fill of roasting pit, interior Enclosure B	1	2
Tipperary	Borris AR33 E2376	2033	2036	1629	Basal fill of roasting pit, interior Enclosure B	4	13
Tipperary	Borris AR33 E2376	525	537	205	Middle fill of metalworking pit, enclosure C	1	100
Tipperary	Borris AR33 E2376	525	536	207	Basal fill of metalworking pit, interior of enclosure C	2	10
Tipperary	Borris AR33 E2376	525	535	1411	Basal fill of kiln A, in interior of enclosure C	3	52
Tipperary	Borris AR33 E2376	525	527	1414	Fill of kiln A, in interior of enclosure C	1	5
Tipperary	Borris AR33 E2376	920	921	522	Basal fill from kiln B, in interior of enclosure C	0	0
Tipperary	Borris AR33 E2376	5	193	1236	Middle fill of ditch, enclosure C south	0	0
Tipperary	Borris AR33 E2376	436	637	1415	Basal fill of the conjoined pits to south of Enclosure C	6	102
Tipperary	Borris AR33 E2376	1943	1949	1430	Single fill of posthole from four post structure, Enclosure C	6	100
Tipperary	Borris AR33 E2376	1970	1971	1436	Single fill of wall slot of structure 6 in interior of enclosure C	0	0
Tipperary	Borris AR33 E2376	1795	1796	1529	Posthole from structure 7, interior enclosure C	2	9
Tipperary	Borris AR33 E2376	882	933	524	Basal fill of metalworking feature	1	19
Tipperary	Borris AR33 E2376	1245	1248	576	Basal fill of stone lined pit (associated with metalworking complex)	3	63
Tipperary	Borris AR33 E2376	1554	1632	1293	Upper fill containing slag from Enclosure D	1	12
Tipperary	Borris AR33 E2376	1662	1660	1309	Lower fill from internal pit from Enclosure D	5	100

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Borris AR33 E2376	1637	1636	1399	Charcoal and heat shattered stone rich fill of pit, south of enclosure D	2	70
Tipperary	Monadreela Site 5 (03E0279)	155	167	26	Basal fill of kiln	4	16
Tipperary	Monadreela Site 8 (03E0299)	100	101	2	Upper fill of kiln	3	51
Tipperary	Monadreela Site 8 (03E0299)	100	102	4	Basal fill of kiln	2	100
Tipperary	Monadreela Site 8 (03E0299)	123	124	6	Basal fill of ditch	3	40
Tipperary	Monadreela Site 8 (03E0299)	119	198	14	Basal fill of linear	5	29
Tipperary	Monadreela Site 8 (03E0299)	171	172	15	Posthole	2	24
Tipperary	Monadreela Site 8 (03E0299)	179	180	16	Posthole	3	50
Tipperary	Monadreela Site 8 (03E0299)	110	109	17	Fill of ditch	6	50
Tipperary	Monadreela Site 8 (03E0299)	110	202	20	Fill of ditch	1	19
Tipperary	Monadreela Site 8 (03E0299)	119	209	10	Basal fill of ditch	1	5
Tipperary	Monadreela Site 8 (03E0299)	125	126	18	Fill of linear ditch	1	1
Tipperary	Monadreela Site 8 (03E0299)	110	109	23	Fill of ditch	2	9
Tipperary	Monadreela Site 8 (03E0299)	187	210	19	Fill of kiln	1	12
Tipperary	Monadreela Site 8 (03E0299)	119	209	22	Basal fill of ditch	1	6
Tipperary	Monadreela Site 9 (03E0345)	106	9	12	Fill of hearth	4	50
Tipperary	Monadreela Site 9 (03E0345)	188	139	16	Fill of posthole	2	27
Tipperary	Monadreela Site 9 (03E0345)	181	181	15	Floor deposit of rectangular structure	1	15
Tipperary	Monadreela Site 9 (03E0345)	191	194	28	Primry fill of wall slot	1	30
Tipperary	Monadreela Site 9 (03E0345)	219	218	36	Fill of posthole	1	6
Tipperary	Monadreela Site 9 (03E0345)	228	246	37	Fill of pit	2	10
Tipperary	Monadreela Site 9 (03E0345)	112	1	35	Fill of linear ditch	1	30
Tipperary	Monadreela Site 9 (03E0345)	112	58	29	Fill of linear ditch	4	73
Tipperary	Monadreela Site 9 (03E0345)	112	149	10	Fill of linear ditch	2	55
Tipperary	Monadreela Site 9 (03E0345)	198	116	17	Fill of boundary ditch	3	55
Tipperary	Monadreela Site 9 (03E0345)	235	233	38	Fill of boundary ditch	1	32
Tipperary	Monadreela Site 9 (03E0345)	108	258	39	Fill of boundary ditch	3	50
Tipperary	Monadreela Site 9 (03E0345)	225	261	40	Basal fill of ditch	1	11
Tipperary	Monadreela Site 11 (03E0346)	7	3	4	Upper fill of pit	6	90
Tipperary	Monadreela Site 11 (03E0346)	7	4	5	Fill of pit	1	4
Tipperary	Monadreela Site 11 (03E0346)	7	5	6	Fill of pit	1	50
Tipperary	Monadreela Site 11 (03E0346)	7	6	7	Basal fill of pit	1	50
Tipperary	Monadreela Site 11 (03E0346)	11	12	15	Pit	2	50
Tipperary	Monadreela Site 11 (03E0346)	23	24	8	Upper fill of pit	1	50
Tipperary	Monadreela Site 11 (03E0346)	23	25	9	Second fill of pit	2	36
Tipperary	Monadreela Site 11 (03E0346)	23	26	10	Fill of pit	3	7
Tipperary	Monadreela Site 11 (03E0346)	23	27	11	Basal fill of pit	1	18
Tipperary	Monadreela Site 11 (03E0346)	23	28	12	Fill of pit	3	26
Tipperary	Monadreela Site 11 (03E0346)	31	29	13	Upper fill of pit	1	50

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Monadreela Site 11 (03E0346)	31	30	14	Basal fill of pit	3	5
Tipperary	Monadreela Site 11 (03E0346)	33	32	17	Fill of pit/hearth	2	4
Tipperary	Monadreela Site 11 (03E0346)	37	36	18	Single fill of pit	1	2
Tipperary	Monadreela Site 11 (03E0346)	150	149	23	Fill of pit	1	3
Tipperary	Monadreela Site 11 (03E0346)	38	42	48	Fill of kiln	5	22
Tipperary	Monadreela Site 11 (03E0346)	38	43	49	Fill of kiln	1	2
Tipperary	Monadreela Site 11 (03E0346)	38	44	50	Fill of kiln	1	2
Tipperary	Monadreela Site 11 (03E0346)	38	46	62	Fill of kiln	1	15
Tipperary	Monadreela Site 11 (03E0346)	38	45	63	Basal fill of kiln	2	15
Tipperary	Monadreela Site 11 (03E0346)	38	47	65	Fill of kiln	1	20
Tipperary	Monadreela Site 11 (03E0346)	58	52	88	Fill of hearth	1	38
Tipperary	Monadreela Site 11 (03E0346)	90	57	90	Stone dump	1	10
Tipperary	Monadreela Site 11 (03E0346)	81	83	94	Mid fill of bedding trench	1	10
Tipperary	Monadreela Site 11 (03E0346)	81	84	109	Mid fill of bedding trench	1	11
Tipperary	Monadreela Site 11 (03E0346)	81	84	95	Fill of bedding trench	2	13
Tipperary	Monadreela Site 11 (03E0346)	81	84	102	Fill of bedding trench	1	20
Tipperary	Monadreela Site 11 (03E0346)	81	85	103	Fill of bedding trench	1	10
Tipperary	Monadreela Site 11 (03E0346)	81	86	96	Fill of bedding trench	2	5
Tipperary	Monadreela Site 11 (03E0346)	81	86	97	Basal fill of bedding trench	1	5
Tipperary	Monadreela Site 11 (03E0346)	81	86	98	Basal fill of bedding trench	1	5
Tipperary	Monadreela Site 11 (03E0346)	81	86	99	Basal fill of bedding trench	3	7
Tipperary	Monadreela Site 11 (03E0346)	81	86	100	Basal fill of bedding trench	1	12
Tipperary	Monadreela Site 11 (03E0346)	81	86	101	Basal fill of bedding trench	1	5
Tipperary	Monadreela Site 11 (03E0346)	81	86	104	Basal fill of bedding trench	3	23
Tipperary	Monadreela Site 12 (03E0393)	200	202	2	Fill of pit	1	14
Tipperary	Monadreela Site 12 (03E0393)	204	203	1	Fill of ditch	2	6
Tipperary	Monadreela Site 12 (03E0393)	205	212	3	Fill of ditch	5	50
Tipperary	Boscabell Site 19 (03E0426)	183	8	28	Fill of kiln chamber	2	39
Tipperary	Boscabell Site 19 (03E0426)	183	184	29	Basal fill of kiln chamber	1	50
Tipperary	Boscabell Site 19 (03E0426)	-	41	30	Burnt spread	3	50
Tipperary	Boscabell Site 19 (03E0426)	75	48	9	Fill of pit	1	13
Tipperary	Boscabell Site 19 (03E0426)	119	120	17	Mid fill of pit	3	36
Tipperary	Boscabell Site 19 (03E0426)	82	78	7	Fill of pit	3	32
Tipperary	Boscabell Site 19 (03E0426)	142	118	23	Fill of pit	1	14
Tipperary	Boscabell Site 19 (03E0426)	179	178	26	Fill of pit	3	43
Tipperary	Boscabell Site 19 (03E0426)	80	79	8	Posthole	1	50
Tipperary	Boscabell Site 19 (03E0426)	84	83	10	Posthole	1	3
Tipperary	Boscabell Site 19 (03E0426)	91	92	11	Posthole	1	9
Tipperary	Boscabell Site 19 (03E0426)	4	194	33	Boundary ditch	3	50

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Boscabell Site 20 (03E0470)	23	24	3	Fill of pit	1	4
Tipperary	Boscabell Site 20 (03E0470)	17	18	4	Upper fill of pit	3	50
Tipperary	Boscabell Site 20 (03E0470)	47	49	7a	Fill of pit	3	44
Tipperary	Boscabell Site 20 (03E0470)	47	49	7b	Fill of pit	2	7
Tipperary	Boscabell Site 20 (03E0470)	47	54	8	Fill of pit	4	50
Tipperary	Boscabell Site 20 (03E0470)	47	55	9	Fill of pit	4	17
Tipperary	Boscabell Site 20 (03E0470)	68	67	10	Fill of pit	4	50
Tipperary	Boscabell Site 20 (03E0470)	84	83	27	Fill of pit	5	50
Tipperary	Boscabell Site 20 (03E0470)	128	129	13	Fill of pit	2	53
Tipperary	Boscabell Site 20 (03E0470)	154	155	14	Fill of pit	3	36
Tipperary	Boscabell Site 20 (03E0470)	160	161	17	Fill of pit	1	80
Tipperary	Boscabell Site 20 (03E0470)	137	136	18	Upper fill of pit	4	18
Tipperary	Boscabell Site 20 (03E0470)	137	143	23	Basal fill of pit	4	50
Tipperary	Boscabell Site 20 (03E0470)	172	235	24	Basal fill of pit	1	8
Tipperary	Boscabell Site 20 (03E0470)	237	173	25	Upper fill of pit	4	32
Tipperary	Hughes' Lot East Site 25ii (03E0730)	753	752	123	Stakehole within inner ringfort ditch	5	63
Tipperary	Hughes' Lot East Site 25ii (03E0730)	760	761	128	Stakehole within inner ringfort ditch	5	55
Tipperary	Hughes' Lot East Site 25ii (03E0730)	731	732	108	Stakehole within inner ringfort ditch	0	0
Tipperary	Hughes' Lot East Site 25ii (03E0730)	704	705	112	Stakehole within inner ringfort ditch	0	0
Tipperary	Hughes' Lot East Site 25ii (03E0730)	712	713	115	Stakehole within inner ringfort ditch	1	6
Tipperary	Hughes' Lot East Site 25ii (03E0730)	710	711	118	Stakehole within inner ringfort ditch	1	3
Tipperary	Hughes' Lot East Site 25ii (03E0730)	756	757	125	Stakehole within inner ringfort ditch	1	12
Tipperary	Hughes' Lot East Site 25ii (03E0730)	658	657	90	Posthole from circular structure within inner ringfort ditch	3	15
Tipperary	Hughes' Lot East Site 25ii (03E0730)	669	718	94	Posthole from circular structure within inner ringfort ditch	1	10
Tipperary	Hughes' Lot East Site 25ii (03E0730)	673	674	101	Posthole from circular structure within inner ringfort ditch	0	0
Tipperary	Hughes' Lot East Site 25ii (03E0730)	740	741	109	Stakehole within inner ringfort ditch	0	0
Tipperary	Hughes' Lot East Site 25ii (03E0730)	670	672	103	Posthole from ancillary structure within inner enclosure	1	9
Tipperary	Hughes' Lot East Site 25ii (03E0730)	727	728	105	Posthole from ancillary structure within inner enclosure	1	8
Tipperary	Hughes' Lot East Site 25ii (03E0730)	738	739	117	Stakehole from ancillary structure within inner enclosure	2	18
Tipperary	Hughes' Lot East Site 25ii (03E0730)	670	671	000A	Posthole from ancillary structure within inner enclosure	1	14
Tipperary	Hughes' Lot East Site 25ii (03E0730)	719	720	95	Pit associated with ancillary structure within inner enclosure	2	22
Tipperary	Hughes' Lot East Site 25ii (03E0730)	722	723	96	Posthole from ancillary structure within inner enclosure	1	11
Tipperary	Hughes' Lot East Site 25ii (03E0730)	670	671	102	Upper fill of posthole rom ancillary structure within inner enclosure	4	38
Tipperary	Hughes' Lot East Site 25ii (03E0730)	724	0725/6	104	Posthole from ancillary structure within inner enclosure	1	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	736	737	116	Stakehole from ancillary structure within inner enclosure	1	8
Tipperary	Hughes' Lot East Site 25ii (03E0730)	675	676	119	Posthole from ancillary structure within inner enclosure	1	10
Tipperary	Hughes' Lot East Site 25ii (03E0730)	748	749	122	Posthole from ancillary structure within inner enclosure	1	8
Tipperary	Hughes' Lot East Site 25ii (03E0730)	763	763	127	Posthole from ancillary structure within inner enclosure	1	8
Tipperary	Hughes' Lot East Site 25ii (03E0730)	133	330	6	Posthole from outer enclosure	1	4

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Hughes' Lot East Site 25ii (03E0730)	241	333	7	Posthole from outer enclosure	2	15
Tipperary	Hughes' Lot East Site 25ii (03E0730)	51	331	8	Posthole from outer enclosure	3	14
Tipperary	Hughes' Lot East Site 25ii (03E0730)	135	136	12	Posthole from outer enclosure	2	44
Tipperary	Hughes' Lot East Site 25ii (03E0730)	137	138	13	Posthole from outer enclosure	4	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	328	355	17	Posthole from outer enclosure	3	24
Tipperary	Hughes' Lot East Site 25ii (03E0730)	396	397	24	Posthole from outer enclosure	1	6
Tipperary	Hughes' Lot East Site 25ii (03E0730)	398	399	25	Posthole from outer enclosure	1	15
Tipperary	Hughes' Lot East Site 25ii (03E0730)	742	743	120	Posthole from outer enclosure	1	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	406	407	27	Posthole from outer enclosure	1	14
Tipperary	Hughes' Lot East Site 25ii (03E0730)	640	641	99	Posthole from outer enclosure	2	16
Tipperary	Hughes' Lot East Site 25ii (03E0730)	639	638	100	Posthole from outer enclosure	1	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	578	579	162	Posthole between inner and outer enclosure	1	12
Tipperary	Hughes' Lot East Site 25ii (03E0730)	616	617	181	Posthole between inner and outer enclosure	1	8
Tipperary	Hughes' Lot East Site 25ii (03E0730)	616	618	187	Posthole between inner and outer enclosure	2	21
Tipperary	Hughes' Lot East Site 25ii (03E0730)	625	626	189	Posthole between inner and outer enclosure	2	15
Tipperary	Hughes' Lot East Site 25ii (03E0730)	573	575	56	Posthole between inner and outer enclosure	3	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	610	611	66	Posthole between inner and outer enclosure	4	61
Tipperary	Hughes' Lot East Site 25ii (03E0730)	620	621	67	Posthole between inner and outer enclosure	1	8
Tipperary	Hughes' Lot East Site 25ii (03E0730)	31	392	75	Isloated postholes	2	17
Tipperary	Hughes' Lot East Site 25ii (03E0730)	25	26	76	Isloated postholes	1	10
Tipperary	Hughes' Lot East Site 25ii (03E0730)	386	387	59	Isloated postholes	2	9
Tipperary	Hughes' Lot East Site 25ii (03E0730)	415	416	69	Isloated postholes	2	15
Tipperary	Hughes' Lot East Site 25ii (03E0730)	415	418	19	Isloated postholes	1	7
Tipperary	Hughes' Lot East Site 25ii (03E0730)	646	647	20	Isloated postholes	1	9
Tipperary	Hughes' Lot East Site 25ii (03E0730)	648	649	21	Isloated postholes	1	25
Tipperary	Hughes' Lot East Site 25ii (03E0730)	650	651	36	Isloated postholes	2	28
Tipperary	Hughes' Lot East Site 25ii (03E0730)	652	653	37	Isloated postholes	4	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	663	664	82	Isloated postholes	1	2
Tipperary	Hughes' Lot East Site 25ii (03E0730)	702	703	84	Isloated postholes	1	9
Tipperary	Hughes' Lot East Site 25ii (03E0730)	706	707	85	Isloated postholes	2	17
Tipperary	Hughes' Lot East Site 25ii (03E0730)	708	709	86	Isloated postholes	2	21
Tipperary	Hughes' Lot East Site 25ii (03E0730)	744	745	89	Isloated postholes	2	5
Tipperary	Hughes' Lot East Site 25ii (03E0730)	764	765	111	Isloated postholes	1	3
Tipperary	Hughes' Lot East Site 25ii (03E0730)	647	646	113	Isloated postholes	2	9
Tipperary	Hughes' Lot East Site 25ii (03E0730)	766	767	114	Isloated postholes	2	11
Tipperary	Hughes' Lot East Site 25ii (03E0730)	308	310	121	Third fill of crop drying kiln	1	5
Tipperary	Hughes' Lot East Site 25ii (03E0730)	308	353	129	Fill of crop drying kiln	1	11
Tipperary	Hughes' Lot East Site 25ii (03E0730)	308	797	130	Fill of crop drying kiln	1	7
Tipperary	Hughes' Lot East Site 25ii (03E0730)	401	402	132	Basal fill of crop drying kiln	1	38

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Hughes' Lot East Site 25ii (03E0730)	401	402	3	Basal fill of crop drying kiln	1	9
Tipperary	Hughes' Lot East Site 25ii (03E0730)	401	402	9	Basal fill of crop drying kiln	2	8
Tipperary	Hughes' Lot East Site 25ii (03E0730)	733	774	147	Fill of crop drying kiln scorching	4	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	733	771	34	Upper fill of crop drying kiln	4	63
Tipperary	Hughes' Lot East Site 25ii (03E0730)	733	772	35	Upper fill of crop drying kiln	3	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	733	773	B	Mid fill of crop drying kiln	3	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	733	774	138	Fill of crop drying kiln scorching	6	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	733	775	139	Fill of crop drying kiln	1	26
Tipperary	Hughes' Lot East Site 25ii (03E0730)	733	776	140	Fill of crop drying kiln	1	21
Tipperary	Hughes' Lot East Site 25ii (03E0730)	733	777	141	Fill of crop drying kiln	1	2
Tipperary	Hughes' Lot East Site 25ii (03E0730)	374	375	142	Fill of pit	2	12
Tipperary	Hughes' Lot East Site 25ii (03E0730)	374	375	143	Fill of pit	1	11
Tipperary	Hughes' Lot East Site 25ii (03E0730)	374	375	144	Middle fill of pit	2	3
Tipperary	Hughes' Lot East Site 25ii (03E0730)	374	375	145	Upper fill of pit	2	21
Tipperary	Hughes' Lot East Site 25ii (03E0730)	475	476	15	Fill of pit	2	7
Tipperary	Hughes' Lot East Site 25ii (03E0730)	584	586	16	Middle fill of pit	2	21
Tipperary	Hughes' Lot East Site 25ii (03E0730)	573	580	14	Upper fill of pit	2	39
Tipperary	Hughes' Lot East Site 25ii (03E0730)	733	735	15	Fill of pit	3	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	778	779	41	Fill of pit	2	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	573	581	49	Upper fill of pit	4	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	654	655	55	Fill of pit	3	17
Tipperary	Hughes' Lot East Site 25ii (03E0730)	147	148	110	Upper fill of pit	1	7
Tipperary	Hughes' Lot East Site 25ii (03E0730)	-	573	146	Spread fill	3	28
Tipperary	Hughes' Lot East Site 25ii (03E0730)	608	609	78	Fill of pit	1	8
Tipperary	Hughes' Lot East Site 25ii (03E0730)	613	09/05/2614	87	Upper fill of hearth	2	23
Tipperary	Hughes' Lot East Site 25ii (03E0730)	608	609	2	Fill of pit	1	4
Tipperary	Hughes' Lot East Site 25ii (03E0730)	793	7946	77	Fill of hearth	2	10
Tipperary	Hughes' Lot East Site 25ii (03E0730)	793	7946	57	Fill of hearth	1	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	793	7946	68	Fill of hearth	3	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	793	795	81	Fill of hearth	4	14
Tipperary	Hughes' Lot East Site 25ii (03E0730)	793	794	148	Fill of hearth	5	33
Tipperary	Hughes' Lot East Site 25ii (03E0730)	112	112	149	Fill of pit	2	24
Tipperary	Hughes' Lot East Site 25ii (03E0730)	48	384	150	Fill of foundation slot trench	1	16
Tipperary	Hughes' Lot East Site 25ii (03E0730)	325	357	152	Fill of foundation slot trench	2	13
Tipperary	Hughes' Lot East Site 25ii (03E0730)	423	423	153	Rake out from kiln	3	35
Tipperary	Hughes' Lot East Site 25ii (03E0730)	423	423	131	Rake out from kiln	1	31
Tipperary	Hughes' Lot East Site 25ii (03E0730)	423	423	22	Rake out from kiln	1	27
Tipperary	Hughes' Lot East Site 25ii (03E0730)	3	534	39	Fill of outer enclosure ditch	3	15
Tipperary	Hughes' Lot East Site 25ii (03E0730)	3	100	28	Upper fill of pit	4	24

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Hughes' Lot East Site 25ii (03E0730)	3	348	29	Basal fill of ditch	1	29
Tipperary	Hughes' Lot East Site 25ii (03E0730)	690	557	30	Ditch recut	6	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	4	568	46	Fill of ditch	3	36
Tipperary	Hughes' Lot East Site 25ii (03E0730)	690	559	72	Ditch recut	4	37
Tipperary	Hughes' Lot East Site 25ii (03E0730)	690	561	61	Ditch recut	5	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	690	562	62	Ditch recut	2	8
Tipperary	Hughes' Lot East Site 25ii (03E0730)	690	563	63	Ditch recut	2	32
Tipperary	Hughes' Lot East Site 25ii (03E0730)	4	566	64	Fill of ditch	1	5
Tipperary	Hughes' Lot East Site 25ii (03E0730)	4	571	71	Fill of inner enclosure ditch	1	11
Tipperary	Hughes' Lot East Site 25ii (03E0730)	4	552	79	Fill of inner enclosure ditch	1	8
Tipperary	Hughes' Lot East Site 25ii (03E0730)	4	572	107	Fill of ditch	4	18
Tipperary	Hughes' Lot East Site 25ii (03E0730)	141	426	31	Basal fill of ditch	3	39
Tipperary	Hughes' Lot East Site 25ii (03E0730)	477	479	42	Fill of ditch	2	16
Tipperary	Hughes' Lot East Site 25ii (03E0730)	477	480	43	Fill of ditch	2	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	337	339	47	Fill of ditch	1	9
Tipperary	Hughes' Lot East Site 25ii (03E0730)	39	524	48	Basal fill of ditch	1	7
Tipperary	Hughes' Lot East Site 25ii (03E0730)	477	478	44	Fill of ditch	1	26
Tipperary	Hughes' Lot East Site 25ii (03E0730)	689	688	93	Fill of ditch	1	5
Tipperary	Hughes' Lot East Site 25ii (03E0730)	366	481	53	Fill of ditch	1	3
Tipperary	Hughes' Lot East Site 25ii (03E0730)	768	769	133	Fill of ditch	2	10
Tipperary	Hughes' Lot East Site 25ii (03E0730)	318	319	4	Upper fill of pit	1	14
Tipperary	Hughes' Lot East Site 25ii (03E0730)	404	405	32	Grave fill	1	9
Tipperary	Hughes' Lot East Site 25ii (03E0730)	35	320	5	Linear ditch	3	26
Tipperary	Hughes' Lot East Site 25ii (03E0730)	3	444	33	Basal fill of ditch	2	13
Tipperary	Hughes' Lot East Site 25ii (03E0730)	659	660	88	Furrow fill	4	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	680	681	92	Irregular feature	3	27
Tipperary	Hughes' Lot East Site 25ii (03E0730)	634	635	154	Fill of ditch	3	24
Tipperary	Hughes' Lot East Site 25ii (03E0730)	502	598	80	Fill of ditch	1	4
Tipperary	Hughes' Lot East Site 25ii (03E0730)	3	344	73	Fill of ditch	2	26
Tipperary	Hughes' Lot East Site 25ii (03E0730)	3	347	10	Basal fill of ditch	2	7
Tipperary	Hughes' Lot East Site 25ii (03E0730)	3	471	163	Basal fill of ditch	3	50
Tipperary	Hughes' Lot East Site 25ii (03E0730)	608	609	80	Fill of hearth	2	24
Tipperary	Hughes' Lot East Site 25ii (03E0730)	326	356	18	Furrow fill	1	10
Tipperary	Hughes' Lot East Site 25ii (03E0730)	35	320	40	Fill of ditch	4	30
Tipperary	Hughes' Lot East Site 25ii (03E0730)	584	585	45	Upper fill of pit	1	50
Tipperary	Hughes' Lot East Site 25iii (03E0746)	29	257	49	Fill of ditch	1	21
Tipperary	Hughes' Lot East Site 25iii (03E0746)	47	305	28	Fill of ditch	1	50
Tipperary	Hughes' Lot East Site 25iv (03E0807)	6	7	1	Charcoal rich fill of posthole	2	9
Tipperary	Hughes' Lot East Site 25iv (03E0807)	8	9	2	Charcoal rich fill of posthole	1	31

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Hughes' Lot East Site 25iv (03E0807)	10	4	3	Charcoal clay fill of pit	2	50
Tipperary	Hughes' Lot East Site 25iv (03E0807)	49	46	4	Charocal clay fill of pit	1	19
Tipperary	Hughes' Lot East Site 25iv (03E0807)	61	62	5	Fill of posthole	2	31
Tipperary	Hughes' Lot East Site 25iv (03E0807)	58	57	7	Fill of pit	3	37
Tipperary	Hughes' Lot East Site 25iv (03E0807)	150	126	8	Fill of corn drying kiln	3	44
Tipperary	Hughes' Lot East Site 25iv (03E0807)	51	140	9	Fill of pit. To the west of the enclosure.	2	15
Tipperary	Hughes' Lot East Site 25iv (03E0807)	139	138	11	Fill of posthole External to ringfort enclosure. Adjacent to corn drying kilns	1	4
Tipperary	Hughes' Lot East Site 25iv (03E0807)	50	50	10	Upper fill of pit	1	21
Tipperary	Hughes' Lot East Site 25iv (03E0807)	148	123	13	Fill of corn drying kiln	1	17
Tipperary	Hughes' Lot East Site 25iv (03E0807)	148	155	14	Fill of corn drying kiln.	5	50
Tipperary	Hughes' Lot East Site 25iv (03E0807)	150	154	15	Basal fill of corn drying kiln	2	25
Tipperary	Hughes' Lot East Site 25iv (03E0807)	150	131	16	Fill of corn drying kiln	3	9
Tipperary	Hughes' Lot East Site 25iv (03E0807)	150	163	17	Fill of corn drying kiln. Area of in situ burning.	1	4
Tipperary	Hughes' Lot East Site 25iv (03E0807)	148	164	18	Fill of corn drying kiln	3	50
Tipperary	Hughes' Lot East Site 25iv (03E0807)	150	166/150	19	Fill of corn drying kiln	1	24
Tipperary	Hughes' Lot East Site 25iv (03E0807)	150	154	21	Basal fill of kiln	1	31
Tipperary	Hughes' Lot East Site 25iv (03E0807)	148	149	22	Upper fill of corn drying kiln	1	50
Tipperary	Farranamanagh Site 39 (03E0757)	11	15 / 16	8	Charcoal rich mix of basal and middle fill of roasting pit	4	50
Tipperary	Farranamanagh Site 39 (03E0757)	23	24	3	Basal fill of cremation pit	3	50
Tipperary	Farranamanagh Site 39 (03E0757)	23	24/23	4	Basal fill of cremation pit	1	6
Tipperary	Farranamanagh Site 39 (03E0757)	23	25	2	Upper fill of cremation pit	1	3
Tipperary	Farranamanagh Site 39 (03E0757)	30	28	5	Single fill of grave cut	1	50
Tipperary	Farranamanagh Site 39 (03E0757)	38	39	12	Upper fill of roasting pit	1	1
Tipperary	Farranamanagh Site 39 (03E0757)	51	52	11	Charcoal rich upper fill of roasting pit	4	34
Tipperary	Farranamanagh Site 39 (03E0757)	51	53	15	Charcoal rich middle fill of roasting pit	1	24
Tipperary	Farranamanagh Site 39 (03E0757)	51	54	13	Basal fill of roasting pit	0	0
Tipperary	Farranamanagh Site 39 (03E0757)	43	55	19	Upper fill pit	2	36
Tipperary	Farranamanagh Site 39 (03E0757)	43	56	17	Basal fill of pit	2	16
Tipperary	Farranamanagh Site 39 (03E0757)	5	87	21	Fill of ditch	2	21
Tipperary	Farranamanagh Site 39 (03E0757)	80	103	23	Upper fill of charcoal production pit	3	50
Tipperary	Farranamanagh Site 39 (03E0757)	40	104	24	Middle fill of charcoal production pit	2	34
Tipperary	Farranamanagh Site 39 (03E0757)	82	111	29	Single fill of roasting pit	3	17
Tipperary	Farranamanagh Site 39 (03E0757)	76	121	31	Upper fill of possible "blind" cremation	4	21
Tipperary	Farranamanagh Site 39 (03E0757)	76	122	35	Middle fill of possible “blind” cremation	2	16
Tipperary	Farranamanagh Site 39 (03E0757)	76	134	34	Fill of possible “blind” cremation pit	1	50
Tipperary	Farranamanagh Site 39 (03E0757)	142	143	45	Fill of possible foundation trench 142	1	50
Tipperary	Farranamanagh Site 39 (03E0757)	145	146	60	Single fill of possible posthole	1	50
Tipperary	Farranamanagh Site 39 (03E0757)	180	149	44	Single fill of narrow slot trench	1	10
Tipperary	Farranamanagh Site 39 (03E0757)	91	158	51	Fill of Lshaped ditch	2	9

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Farranamanagh Site 39 (03E0757)	135	200	47	Upper fill of ditch recut	2	8
Tipperary	Farranamanagh Site 39 (03E0757)	135	201	48	Basal fill of ditch recut	1	27
Tipperary	Farranamanagh Site 39 (03E0757)	205	206	58	Fill of posthole	2	50
Tipperary	Farranamanagh Site 39 (03E0757)	222	223	59	Fill of posthole	2	30
Tipperary	Windmill Site 35 (03E0424)	4	3	2	Fill of pit	1	14
Tipperary	Windmill Site 35 (03E0424)	6	5	1	Fill of pit	3	18
Tipperary	Windmill Site 35 (03E0424)	22	15	4	Fill of posthole	2	50
Tipperary	Windmill Site 35 (03E0424)	24	21	8	Fill of posthole	2	50
Tipperary	Windmill Site 35 (03E0424)	32	23	7	Fill of posthole	1	5
Tipperary	Windmill Site 35 (03E0424)	38	31	3	Fill of pit	1	13
Tipperary	Windmill Site 35 (03E0424)	45	37	6	Fill of pit	1	14
Tipperary	Windmill Site 35 (03E0424)	54	46	5	Fill of posthole	1	1
Tipperary	Toureen Peckaun (05E0247)	33	35	1	Fil of linear	1	50
Tipperary	Toureen Peckaun (05E0247)	91	38	2	Fill of pit	1	12
Tipperary	Toureen Peckaun (05E0247)	-	63	3	Fill of spread	1	50
Tipperary	Toureen Peckaun (05E0247)	69	70	4	Fill of posthole	2	33
Tipperary	Toureen Peckaun (05E0247)	81	80	5	Fill of drain	1	50
Tipperary	Toureen Peckaun (05E0247)	94	95	6	Fill of drain	4	50
Tipperary	Toureen Peckaun (05E0247)	-	97	7	Deposit	6	50
Tipperary	Toureen Peckaun (05E0247)	-	103	8	Deposit	4	50
Tipperary	Toureen Peckaun (05E0247)	20	19	9	Fill of postpipe	4	33
Tipperary	Toureen Peckaun (05E0247)	231	176	10	Fill of linear	5	50
Tipperary	Toureen Peckaun (05E0247)	154	154	11	Fill of posthole palisade	4	43
Tipperary	Toureen Peckaun (05E0247)	1120	1117	12	Possible prehistoric layers	4	50
Tipperary	Toureen Peckaun (05E0247)	752	752	13	Palisade posthole Phase 1	4	50
Tipperary	Toureen Peckaun (05E0247)	766	765	14	Fill of posthole Phase 1	1	15
Tipperary	Toureen Peckaun (05E0247)	175	175	15	Fill of outer fence Phase 2	1	11
Tipperary	Toureen Peckaun (05E0247)	392	392	16	Lower fill of posthole Phase 2	3	50
Tipperary	Toureen Peckaun (05E0247)	740	710	17	Fill of posthole Phase 2	2	50
Tipperary	Toureen Peckaun (05E0247)	726	726	18	Occupation layer	3	10
Tipperary	Toureen Peckaun (05E0247)	875	873	19	Fill of posthole Phase 2	3	31
Tipperary	Toureen Peckaun (05E0247)	957	957	20	Sealing layer over 997	3	22
Tipperary	Toureen Peckaun (05E0247)	996	994	21	Fill of linear	1	50
Tipperary	Toureen Peckaun (05E0247)	1010	998	22	Fill of posthole 1010 Phase 2	2	38
Tipperary	Toureen Peckaun (05E0247)	103	103	23	Fill of drain Phase 2	2	50
Tipperary	Toureen Peckaun (05E0247)	207	206	24	Fill of posthole Phase 2	2	50
Tipperary	Toureen Peckaun (05E0247)	342	275	25	Fill of posthole Phase 2	3	50
Tipperary	Toureen Peckaun (05E0247)	284	284	26	Fill of outer fence Phase 2	3	50
Tipperary	Toureen Peckaun (05E0247)	297	285	27	Fill of W fence Phase 2	2	50

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Tipperary	Toureen Peckaun (05E0247)	291	291	28	Upper fill of posthole Phase 2	4	50
Tipperary	Toureen Peckaun (05E0247)	370	348	29	Upper fill of posthole Phase 2	1	50
Tipperary	Toureen Peckaun (05E0247)	407	407	30	Fill of slot fence Phase 2	2	50
Tipperary	Toureen Peckaun (05E0247)	423	423	31	Fill of outer ence Phase 2	3	50
Tipperary	Toureen Peckaun (05E0247)	464	426	32	Fill of slot fence Phase 2	2	50
Tipperary	Toureen Peckaun (05E0247)	447	441	33	Fill of stakehole from fence Phase 2	3	50
Tipperary	Toureen Peckaun (05E0247)	174	468	34	Fill of fence Phase 2 (N end)	4	50
Tipperary	Toureen Peckaun (05E0247)	723	667	35	Fill of pit 723 Phase 2	1	27
Tipperary	Toureen Peckaun (05E0247)	740	740	36	Fill of posthole Phase 2	4	50
Tipperary	Toureen Peckaun (05E0247)	747	741	37	Fill of ditch 747 Phase 2	2	50
Tipperary	Toureen Peckaun (05E0247)	744	743	38	Fill of postpipe Phase 2	2	50
Tipperary	Toureen Peckaun (05E0247)	747	745	39	Fill of ditch 747 Phase 2	1	42
Tipperary	Toureen Peckaun (05E0247)	848	848	40	Fill of fence Phase 2	4	50
Tipperary	Toureen Peckaun (05E0247)	928	925	41	Gate slot Phase 2	3	50
Tipperary	Toureen Peckaun (05E0247)	967	967	42	Fill of posthole Phase 2	3	50
Tipperary	Toureen Peckaun (05E0247)	161/387	293	43	Upper fill of pit 161/387 Phase 2/3	4	50
Tipperary	Toureen Peckaun (05E0247)	989	945	44	Fill of well Phase 2/3	3	72
Tipperary	Toureen Peckaun (05E0247)	154	318	45	Fill of pit 154 Phase 2/3	2	24
Tipperary	Toureen Peckaun (05E0247)	432	429	46	Basal fill of slot Phase 3	1	30
Tipperary	Toureen Peckaun (05E0247)	892	892	47	Deposit fill Phase 3	3	38
Tipperary	Toureen Peckaun (05E0247)	843	681	48	Fill of kiln 843 Phase 3	3	50
Tipperary	Toureen Peckaun (05E0247)	843	976	49	Upper fill of kiln 843 Phase 3	1	50
Tipperary	Toureen Peckaun (05E0247)	721	721	50	Hearth rakeout Phase 3 under 720	4	50
Tipperary	Toureen Peckaun (05E0247)	448	308	51	Fill of pit 448	3	50
Tipperary	Toureen Peckaun (05E0247)	948	982	52	Fill of pit 948	1	29
Tipperary	Toureen Peckaun (05E0247)	992	992	53	Deposit fill Phase 3 under 991	1	50
Tipperary	Toureen Peckaun (05E0247)	319	320	54	Recilinear deposit Phase 3	2	41
Tipperary	Toureen Peckaun (05E0247)	340	340	55	Recilinear deposit Phase 3	2	50
Tipperary	Toureen Peckaun (05E0247)	508	508	56	Fill of posthole Phase 3 Trench F	3	50
Tipperary	Toureen Peckaun (05E0247)	511	511	57	Fill of posthole Phase 3 Trench F	2	50
Tipperary	Toureen Peckaun (05E0247)	522	522	58	Fill of posthole Phase 3 Trench F	2	35
Kilkenny	Baysrath AR5354 (E2517)	18	18	1	Fill of ditch	1	50
Kilkenny	Baysrath AR5354 (E2517)	55	55	15	Charcoal rich deposit	2	50
Kilkenny	Tinvaun AR066 Site 3 (E3606)	14	14	1	Fill of slot trench	6	50
Kilkenny	Tinvaun AR066 Site 3 (E3606)	40	40	29	Fill of slot trench	2	9
Kilkenny	Tinvaun AR066 Site 3 (E3606)	13	13	1	Fill of ditch	3	50
Kilkenny	Tinvaun AR066 Site 3 (E3606)	43	43	29	Fill of waste pit	4	16
Kilkenny	Tinvaun AR066 Site 3 (E3606)	51	51	36	Fill of slot trench	4	50
Kilkenny	Tinvaun AR066 Site 3 (E3606)	51	51	50	Fill of slot trench	1	50

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Kilkenny	Tinvaun AR066 Site 3 (E3606)	59	59	23	Fill of posthole	1	7
Kilkenny	Tinvaun AR066 Site 3 (E3606)	66	66	14	Fill of posthole	4	37
Kilkenny	Tinvaun AR066 Site 3 (E3606)	68	68	28	Fill of slot trench	3	47
Kilkenny	Tinvaun AR066 Site 3 (E3606)	68	68	28	Fill of slot trench	4	52
Kilkenny	Tinvaun AR066 Site 3 (E3606)	120	120	77	Fill above floor surface	2	50
Kilkenny	Tinvaun AR066 Site 3 (E3606)	134	134	53	Fill of posthole	1	12
Kilkenny	Tinvaun AR066 Site 3 (E3606)	100	100	37	Fill of stakehole	1	4
Kilkenny	Tinvaun AR066 Site 3 (E3606)	108	108	55	Fill of hearth	1	50
Kilkenny	Tinvaun AR066 Site 3 (E3606)	111	111	41	Fill of posthole	1	50
Kilkenny	Tinvaun AR066 Site 3 (E3606)	132	132	52	Fill of posthole	1	50
Kilkenny	Tinvaun AR066 Site 3 (E3606)	163	163	62	Fill of posthole	3	50
Kilkenny	Tinvaun AR066 Site 3 (E3606)	184	184	68	Fill of posthole	2	16
Kilkenny	Knockadrina Site 2 (E3611)	147	148	32	Fill of pit	1	16
Kilkenny	Knockadrina Site 2 (E3611)	124	125	33	Fill of pit	2	4
Kilkenny	Knockadrina Site 2 (E3611)	128	152	35	Fill of pit	2	50
Kilkenny	Knockadrina Site 2 (E3611)	130	131	36	Fill of posthole	1	5
Kilkenny	Knockadrina Site 2 (E3611)	138	175	38	Fill of slot trench	1	50
Kilkenny	Knockadrina Site 2 (E3611)	517	528	114	Fill of pit	1	2
Kilkenny	Knockadrina Site 2 (E3611)	518	518	115	Fill of pit	2	50
Kilkenny	Knockadrina Site 2 (E3611)	518	529	118	Fill of pit	3	50
Kilkenny	Knockadrina Site 2 (E3611)	183	190	113	Fill of pit	1	50
Kilkenny	Knockadrina Site 2 (E3611)	6	220	48	Fill of ditch	1	12
Kilkenny	Knockadrina Site 2 (E3611)	6	220	49	Fill of ditch	2	12
Kilkenny	Knockadrina Site 2 (E3611)	6	227	55	Fill of ditch	2	50
Kilkenny	Knockadrina Site 2 (E3611)	6	20	6	Fill of ditch	3	36
Kilkenny	Knockadrina Site 2 (E3611)	6	198	102	Fill of ditch	2	50
Kilkenny	Knockadrina Site 2 (E3611)	6	198	104	Fill of ditch	1	50
Kilkenny	Knockadrina Site 2 (E3611)	6	44	92	Fill of ditch	5	50
Kilkenny	Knockadrina Site 2 (E3611)	296	369	88	Fill of linear	3	50
Kilkenny	Knockadrina Site 2 (E3611)	296	369	90	Fill of linear	1	50
Kilkenny	Knockadrina Site 2 (E3611)	222	224	101	Fill of linear	1	50
Kilkenny	Knockadrina Site 2 (E3611)	446	447	105	Fill of pit	1	5
Kilkenny	Knockadrina Site 2 (E3611)	4	13	11	Fill of slot in enclosure	1	5
Kilkenny	Knockadrina Site 2 (E3611)	244	245	79	Fill of posthole	1	6
Kilkenny	Knockadrina Site 2 (E3611)	248	249	61	Fill of posthole	1	2
Kilkenny	Knockadrina Site 2 (E3611)	248	278	62	Fill of posthole	1	5
Kilkenny	Knockadrina Site 2 (E3611)	248	279	63	Fill of posthole	4	50
Kilkenny	Knockadrina Site 2 (E3611)	340	257	67	Ditch in house	2	37
Kilkenny	Knockadrina Site 2 (E3611)	340	341	98	Ditch in house	3	44

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Kilkenny	Knockadrina Site 2 (E3611)	359	361	84	Fill of slot trench	2	50
Kilkenny	Knockadrina Site 2 (E3611)	310	312	69	Fill of posthole	3	50
Kilkenny	Knockadrina Site 2 (E3611)	394	395	95	Fill of furnace	1	20
Kilkenny	Knockadrina Site 2 (E3611)	14	15	5	Fill of hearth	6	50
Kilkenny	Knockadrina Site 2 (E3611)	274	275	72	Fill of pit	4	42
Kilkenny	Knockadrina Site 2 (E3611)	537	540	117	Fill of kiln	1	4
Kilkenny	Kellysgrange Site 3 (E3576)	11	11	5	Fill of kiln	1	50
Kilkenny	Kellysgrange Site 3 (E3576)	15	15	2	Fill of posthole	2	50
Kilkenny	Kellysgrange Site 3 (E3576)	16	16	8A	Fill of kiln	1	14
Kilkenny	Kellysgrange Site 3 (E3576)	16	16	8B	Fill of kiln	3	50
Kilkenny	Kellysgrange Site 3 (E3576)	19	19	7	Fill of kiln	1	37
Kilkenny	Kellysgrange Site 3 (E3576)	26	26	11	Fill of kiln	2	50
Kilkenny	Kellysgrange Site 3 (E3576)	31	31	17	Fill of kiln	4	50
Kilkenny	Kellysgrange Site 3 (E3576)	33	33	18	Fill of kiln	4	15
Kilkenny	Kellysgrange Site 3 (E3576)	38	38	21	Fill of kiln	7	46
Kilkenny	Kellysgrange Site 3 (E3576)	44	44	25	Fill of kiln	5	56
Kilkenny	Kellysgrange Site 3 (E3576)	46	46	12	Fill of kiln	7	50
Kilkenny	Kellysgrange Site 3 (E3576)	49	49	22	Fill of kiln	6	39
Kilkenny	Kellysgrange Site 3 (E3576)	56	56	31	Fill of kiln	8	40
Kilkenny	Kellysgrange Site 3 (E3576)	61	61	28	Fill of kiln	5	53
Kilkenny	Kellysgrange Site 3 (E3576)	66	66	20	Fill of kiln	5	50
Kilkenny	Kellysgrange Site 3 (E3576)	67	67	27	Fill of kiln	4	50
Kilkenny	Kellysgrange Site 3 (E3576)	69	69	32	Fill of kiln	6	50
Kilkenny	Kellysgrange Site 3 (E3576)	71	71	33	Fill of kiln	5	39
Kilkenny	Holdenstown Site 1 (E3681)	22	32	7	Fill of ringditch 1	4	37
Kilkenny	Holdenstown Site 1 (E3681)	22	28	8	Fill of ringditch 1	4	50
Kilkenny	Holdenstown Site 1 (E3681)	40	41	9	Fill of posthole	2	7
Kilkenny	Holdenstown Site 1 (E3681)	40	42	10	Fill of posthole	1	5
Kilkenny	Holdenstown Site 1 (E3681)	22	39	11	Fill of ringditch 1	6	50
Kilkenny	Holdenstown Site 1 (E3681)	22	20	12	Fill of ringditch 1	2	2
Kilkenny	Holdenstown Site 1 (E3681)	51	48	24	Upper fill of recut ringditch 2	6	50
Kilkenny	Holdenstown Site 1 (E3681)	51	50	25	Basal fill of recut ringditch 2	5	50
Kilkenny	Holdenstown Site 1 (E3681)	51	50	35	Basal fill of recut ringditch 2	1	50
Kilkenny	Holdesntown Site 2 (E3630)	32	32	8	Fill of grave cut	2	14
Kilkenny	Holdesntown Site 2 (E3630)	47	47	11	Fill of pit	5	33
Kilkenny	Holdesntown Site 2 (E3630)	52	52	16	Fill of posthole	3	50
Kilkenny	Holdesntown Site 2 (E3630)	80	80	21	Fill of hearth	5	50

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Kilkenny	Holdesntown Site 2 (E3630)	93	93	26	Fill of grave cut Burial 2	5	46
Kilkenny	Holdesntown Site 2 (E3630)	181	181	174	Fill of grave cut Burial 66	3	50
Kilkenny	Holdesntown Site 2 (E3630)	182	182	118	Fill of kiln	1	10
Kilkenny	Holdesntown Site 2 (E3630)	182	182	111	Fill of kiln	4	50
Kilkenny	Holdesntown Site 2 (E3630)	183	183	118	Fill of kiln	1	1
Kilkenny	Holdesntown Site 2 (E3630)	192	192	108	Fill of kiln	4	50
Kilkenny	Holdesntown Site 2 (E3630)	200	200	116	Fill of kiln	3	6
Kilkenny	Holdesntown Site 2 (E3630)	202	202	114	Fill of kiln	4	19
Kilkenny	Holdesntown Site 2 (E3630)	243	243	135	Fill of hearth	2	50
Kilkenny	Holdesntown Site 2 (E3630)	298	297	159	Fill of grave cut	2	50
Kilkenny	Holdesntown Site 2 (E3630)	305	304	169	Fill of grave cut Burial 49	2	7
Kilkenny	Holdesntown Site 2 (E3630)	366	367	188	Fill of grave cut Burial 66	2	50
Kilkenny	Holdesntown Site 2 (E3630)	367	368	225	Fill of grave cut Burial 66	2	50
Kilkenny	Danesfort Site 5 (E3456)	555	122	214	Fill of pit	4	20
Kilkenny	Danesfort Site 5 (E3456)	518	123	152	Fill of pit	5	45
Kilkenny	Danesfort Site 5 (E3456)	369	124	109	Fill of pit	2	15
Kilkenny	Danesfort Site 5 (E3456)	418	414	125	Fill of pit	1	4
Kilkenny	Danesfort Site 5 (E3456)	293	7	14	Fill of kiln	5	31
Kilkenny	Danesfort Site 5 (E3456)	293	294	28	Fill of kiln	2	3
Kilkenny	Danesfort Site 5 (E3456)	293	298	42	Fill of kiln	1	13
Kilkenny	Danesfort Site 6 (E3538)	5	4	3	Stakehole fill	2	27
Kilkenny	Danesfort Site 6 (E3538)	60	61	42	Pit fill	4	50
Kilkenny	Danesfort Site 6 (E3538)	69	68	18	Pit fill	1	50
Kilkenny	Danesfort Site 6 (E3538)	88	87	30	Pit fill	2	50
Kilkenny	Danesfort Site 6 (E3538)	91	90	19	Pit fill	6	50
Kilkenny	Danesfort Site 6 (E3538)	110	111	35	Slot trench fill	2	3
Kilkenny	Danesfort Site 6 (E3538)	119	118	36	Pit fill	1	50
Kilkenny	Danesfort Site 6 (E3538)	157	156	33	Pit fill	2	50
Kilkenny	Danesfort Site 6 (E3538)	169	168	63	Pit fill	3	50
Kilkenny	Danesfort Site 6 (E3538)	179	180	87	Pit fill	1	50
Kilkenny	Danesfort Site 6 (E3538)	10	10	4	Fill of hearth	1	50
Kilkenny	Danesfort Site 6 (E3538)	12	12	3	Fill of hearth	1	3
Kilkenny	Danesfort Site 6 (E3538)	15	15	7	Fill of hearth	2	6
Kilkenny	Danesfort Site 6 (E3538)	49	49	11	Fill of pit	1	15
Kilkenny	Kilree Site 3 (E3643)	9	31	16	Upper fill of ditch	1	5
Kilkenny	Kilree Site 3 (E3643)	84	85	36	Single fill of pit	2	50
Kilkenny	Kilree Site 3 (E3643)	97	96	42	Upper fill of pit	3	5

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Kilkenny	Kilree Site 3 (E3643)	410	76	50	Upper fill of pit	3	54
Kilkenny	Kilree Site 3 (E3643)	138	145	61	Single fill of pit	2	5
Kilkenny	Kilree Site 3 (E3643)	184	154	66	Middle fill of grave cut Burial 2	4	45
Kilkenny	Kilree Site 3 (E3643)	395	173	89	Third fill of kiln flue	2	7
Kilkenny	Kilree Site 3 (E3643)	395	195	90	Stone lining of kiln	2	50
Kilkenny	Kilree Site 3 (E3643)	198	199	92	Single fill of posthole	6	24
Kilkenny	Kilree Site 3 (E3643)	9	218	116	Upper fill of ditch	6	50
Kilkenny	Kilree Site 3 (E3643)	392	94	120	Upper fill of curvilinear feature	2	3
Kilkenny	Kilree Site 3 (E3643)	738	234	133	Upper fill of redeposited deposit of souterrain	1	2
Kilkenny	Kilree Site 3 (E3643)	738	236	134	Upper fill of redeposited deposit of souterrain	2	38
Kilkenny	Kilree Site 3 (E3643)	392	246	147	Basal fill of curvilinear ditch	2	34
Kilkenny	Kilree Site 3 (E3643)	395	173	149	Fill of kiln flue	2	7
Kilkenny	Kilree Site 3 (E3643)	392	258	162	Upper fill of curvilinear ditch	3	50
Kilkenny	Kilree Site 3 (E3643)	9	257	175	Basal fill of ditch	3	6
Kilkenny	Kilree Site 3 (E3643)	276	275	176	Fill of posthole	1	3
Kilkenny	Kilree Site 3 (E3643)	392	265	183	Upper fill of curvilinear feature	2	2
Kilkenny	Kilree Site 3 (E3643)	309	120	245	Fill of posthole	2	2
Kilkenny	Kilree Site 3 (E3643)	344	308	254	Fill of grave cut Burial 3	3	8
Kilkenny	Kilree Site 3 (E3643)	344	308	255	Fill of grave cut Burial 3	1	50
Kilkenny	Kilree Site 3 (E3643)	127	127	328	Fill of deposit	1	1
Kilkenny	Kilree Site 3 (E3643)	374	375	329	Fill of pit	1	1
Kilkenny	Kilree Site 3 (E3643)	395	290	351	Fill of kiln flue	2	50
Kilkenny	Kilree Site 3 (E3643)	410	76	368	Upper fill of pit	1	2
Kilkenny	Kilree Site 3 (E3643)	410	80	377	Basal fill of pit	1	2
Kilkenny	Kilree Site 3 (E3643)	468	453	414	Fill of grave cut Burial 4	2	6
Kilkenny	Kilree Site 3 (E3643)	468	453	415	Fill of grave cut Burial 4	2	8
Kilkenny	Kilree Site 3 (E3643)	465	466	418	Fill of kiln	2	6
Kilkenny	Kilree Site 3 (E3643)	473	472	422	Fill of posthole	3	51
Kilkenny	Kilree Site 3 (E3643)	529	530	446	Fill of posthole	1	6
Kilkenny	Kilree Site 3 (E3643)	541	540	454	Fill of posthole	1	1
Kilkenny	Kilree Site 3 (E3643)	549	550	462	Fill of pit	1	1
Kilkenny	Kilree Site 3 (E3643)	496	561	467	Basal fill of kiln	1	5
Kilkenny	Kilree Site 3 (E3643)	559/738	586	472	Basal fill of drophole in souterrain	2	4
Kilkenny	Kilree Site 3 (E3643)	532/719	587	473	Basal fill of drophole in souterrain	1	21
Kilkenny	Kilree Site 3 (E3643)	532	570	474	Middle fill of drophole in souterrain	1	1
Kilkenny	Kilree Site 3 (E3643)	738	573	491	Upper fill of drophole in souterrain	2	50
Kilkenny	Kilree Site 3 (E3643)	738	762	686	Basal fill of souterrain	2	7
Kilkenny	Kilree Site 3 (E3643)	719	723	690	Basal fill of souterrain	3	50
Kilkenny	Kilree Site 3 (E3643)	719	767	692	Fill of souterrain	2	8

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Kilkenny	Kilree Site 3 (E3643)	719	798	753	Lower fill of chamber in souterrain	3	44
Kilkenny	Kilree Site 3 (E3643)	719	803	768	Lower fill of chamber in souterrain	3	51
Kilkenny	Kilree Site 3 (E3643)	9	28	814	Basal fill of ditch	2	50
Kilkenny	Kilree Site 3 (E3643)	719	860	815	Floor surface of souterrain between chamber and passageway	1	16
Kilkenny	Kilree Site 4 (E3730)	66	66	64	Upper fill of kiln	3	25
Kilkenny	Kilree Site 4 (E3730)	67	67	65	Fill of waste pit	1	1
Kilkenny	Kilree Site 4 (E3730)	85	85	90	Fill of pit	1	1
Kilkenny	Kilree Site 4 (E3730)	86	86	161	Fill of enclosure ditch	1	1
Kilkenny	Kilree Site 4 (E3730)	88	99	144	Fill of enclosure ditch	1	1
Kilkenny	Kilree Site 4 (E3730)	115	115	8	Fill of outer ringditch	1	1
Kilkenny	Kilree Site 4 (E3730)	120	120	81	Fill of kiln	1	1
Kilkenny	Kilree Site 4 (E3730)	165	165	99	Fill of enclosure ditch	2	50
Kilkenny	Kilree Site 4 (E3730)	237	237	135	Fill of enclosure ditch	3	37
Kilkenny	Kilree Site 4 (E3730)	271	271	157	Fill of posthole	2	23
Kilkenny	Kilree Site 4 (E3730)	273	273	156	Fill of posthole	5	40
Kilkenny	Kilree Site 4 (E3730)	287	287	154	Fill of slot trench	5	52
Kilkenny	Kilree Site 4 (E3730)	282	282	150	Fill of pit	3	27
Kilkenny	Kilree Site 4 (E3730)	294	294	160	Fill of kiln	2	10
Kilkenny	Kilree Site 4 (E3730)	300	300	166	Fill of pit	1	26
Kilkenny	Kilree Site 4 (E3730)	316	316	190	Fill of kiln	4	51
Kilkenny	Kilree Site 4 (E3730)	316	316	189	Fill of kiln	2	52
Kilkenny	Templemartin Site 1 (E3849)	3	5	2	Middle fill of kiln	2	50
Kilkenny	Templemartin Site 1 (E3849)	3	10	3	Basal fill of kiln	1	50
Kilkenny	Jordanstown Site 2 (E3851)	4	11	3	Fill of kiln	4	30
Kilkenny	Jordanstown Site 2 (E3851)	20	23	8	Fill of pit	2	50
Kilkenny	Jordanstown Site 2 (E3851)	119	120	23	Fill of pit	1	50
Kilkenny	Shankill Site 2 (E3738)	10	10	3	Fill of kiln	2	66
Kilkenny	Shankill Site 2 (E3738)	27	24/27	7	Fill of kiln	1	15
Kilkenny	Shankill Site 5 (E3850)	62	63	12	Fill of hearth	1	50
Kilkenny	Shankill Site 5 (E3850)	62	64	13	Fill of hearth	1	50
Kilkenny	Leggetsrath East Site 1 (E3734)	11	35	15	Fill of deposit	5	44
Kilkenny	Leggetsrath East Site 1 (E3734)	114	94	35	Fill of posthole	6	50
Kilkenny	Leggetsrath East Site 1 (E3734)	5	33	67	Fill of foundation trench	4	50
Kilkenny	Leggetsrath East Site 1 (E3734)	105	103	26	Fill of stakehole	2	13
Kilkenny	Leggetsrath East Site 1 (E3734)	132	137	44	Fill of pit	1	5
Kilkenny	Leggetsrath East Site 1 (E3734)	276	220	128	Fill of kiln	1	50
Kilkenny	Leggetsrath East Site 1 (E3734)	276	275	129	Fill of kiln	2	11
Kilkenny	Kellysmount Site 5 (E3858)	3	5	1	Fill of linear	5	50
Kilkenny	Kellysmount Site 5 (E3858)	68	70	22	Fill of pit	4	50

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Kilkenny	Milltown AR03-05 (E2499)	130	72	60	pit C130	4	50
Kilkenny	Milltown AR03-05 (E2499)	122	128	76	Fill of kiln pit	3	11
Kilkenny	Milltown AR03-05 (E2499)	81	24	27	Fill of kiln chamber	3	14
Kilkenny	Milltown AR03-05 (E2499)	102	46	29	Fill of pit	3	24
Kilkenny	Milltown AR03-05 (E2499)	101	52	30	Fill of pit	3	50
Kilkenny	Milltown AR03-05 (E2499)	204	203	102	Fill of pit	3	50
Kilkenny	Milltown AR03-05 (E2499)	107	45	37	Fill of pit	1	50
Kilkenny	Milltown AR03-05 (E2499)	126	116	48	Fill of furnace	6	58
Kilkenny	Milltown AR03-05 (E2499)	130	75	66	Fill of pit	4	10
Kilkenny	Milltown AR03-05 (E2499)	195	49	79	Fill of pit	5	26
Kilkenny	Milltown AR03-05 (E2499)	110	80	40	Fill of pit	4	24
Kilkenny	Milltown AR03-05 (E2499)	118	78	47	Fill of pit	5	77
Kilkenny	Milltown AR03-05 (E2499)	99	42	104	Fill of pit	5	50
Kilkenny	Milltown AR03-05 (E2499)	30	10	4	Fill of posthole	2	102
Kilkenny	Milltown AR03-05 (E2499)	213	14	7	Fill of posthole	6	39
Kilkenny	Milltown AR03-05 (E2499)	123	17	54	Fill of furnace	5	50
Kilkenny	Ballykeoghan AR10-12 (E2501)	149	150	73	Fill of kiln	6	74
Kilkenny	Ballykeoghan AR10-12 (E2501)	221	221	111	Fill of kiln	3	38
Kilkenny	Ballykeoghan AR10-12 (E2501)	7	106	49	Fill of kiln stokehole	1	30
Kilkenny	Ballykeoghan AR10-12 (E2501)	143	143	64	Fill of cooking pit	1	4
Kilkenny	Scart and Rahard A019 (E2504)	50	50	2	Back fill of kiln	5	118
Kilkenny	Scart AR020 (E2505)	15	22	11	Fill of kiln	6	44
Kilkenny	Scart AR020 (E2505)	15	23	12	Fill of kiln	2	45
Kilkenny	Scart AR020 (E2505)	15	25	14	Fill of kiln bowl	1	20
Kilkenny	Scart AR020 (E2505)	34	35	27	Fill of linear	4	13
Kilkenny	Scart AR020 (E2505)	32	41	17	Fill of kiln flue	1	20
Kilkenny	Scart AR020 (E2505)	20	45	18	Fillo f hearth (kiln)	1	50
Kilkenny	Scart AR020 (E2505)	53	49	24	Fill of pit	3	50
Kilkenny	Coolmore AR045 (E2514)	15	15	7	Fill of kiln chamber	4	50
Kilkenny	Coolmore AR045 (E2514)	16	16	10	Fill of kiln chamber	6	50
Kilkenny	Coolmore AR045 (E2514)	17	17	17	Basal fill of kiln	5	46
Kilkenny	Earlsrath AR030 (E2510)	6	13	4	Single fill of pit	4	15
Kilkenny	Earlsrath AR030 (E2510)	63	67	12	Single fill of pit	2	2
Kilkenny	Earlsrath AR030 (E2510)	75	78	21	Fill of ditch	3	9
Kilkenny	Earlsrath AR030 (E2510)	3	59	49	Fill of enclosure ditch	4	76
Kilkenny	Earlsrath AR033 (E3007)	10	10	2	Fill of spread containing pottery	1	110
Kilkenny	Earlsrath AR033 (E3007)	11	11	4	Fill of spread containing pottery	1	100
Kilkenny	Rahard West AR17-18 (2503)	4	2	2	Fill of hearth	1	100
Kilkenny	Rahard West AR17-18 (2503)	21	5	8	Fill of ditch	3	62

County	Site Name	Context no. (cut)	Context no. (fill)	Sample no.	Context details	No. of taxa	No. of fragments
Kilkenny	Riceland AR01 (08E0135)	6	9	1	Fill of waste pit	1	50
Carlow	Moanduff Site 1 (E3839)	78	198	32	pit C78	1	50
Carlow	Moanduff Site 1 (E3839)	141	142	38	Fill of stakehole	1	50
Carlow	Moanduff Site 1 (E3839)	147	148	37	Fill of trough	4	24
Carlow	Moanduff Site 2 (E3735)	28	28	5	Fill of hearth	3	25
Carlow	Moanduff Site 2 (E3735)	258	258	126	Fill of kiln furnace	1	50
Carlow	Moanduff Site 2 (E3735)	258	429	112	Fill of kiln furnace	3	50
Carlow	Coneykeare Site 1 (E3683)	23	23	4	Fill of kiln	3	50
Carlow	Coneykeare Site 1 (E3683)	48	48	7	Fill of posthole	2	15
Carlow	Coneykeare Site 1 (E3683)	53	53	16	Fill of posthole	1	2
Carlow	Coneykeare Site 1 (E3683)	68	68	22	Fill of posthole	3	50
Carlow	Coneykeare Site 1 (E3683)	110	110	42	Fill of enclosure ditch	1	50

Appendix 3. List of all wood taxa identifications (arranged by site)

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Gortmakellis AR01	153	Kiln	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	84	Kiln	0	0	0	0	12	14	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	36	Kiln	40	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	87	Kiln	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	197	Kiln	6	0	6	0	0	38	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	57	Kiln	6	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	58	Kiln	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	76	Hearth	4	0	0	16	27	0	0	0	0	3	0	0	0	0	0	0	0	0
Gortmakellis AR01	412	Posthole	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	413	Pit	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	391	Pit	12	0	5	1	11	0	0	0	0	1	0	0	0	0	0	0	0	0
Gortmakellis AR01	14	Pit	2	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	32	Pit	5	20	4	0	17	0	0	0	0	4	0	0	0	0	0	0	0	0
Gortmakellis AR01	217	Pit	48	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	348	Ditch	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	385	Ditch	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	135	Ditch	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	81	Ditch	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	378	Ditch	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gortmakellis AR01	95	Ditch	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moycarkey AR12	4	Charcoal production pit	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moycarkey AR13	10	Pit	60	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moycarkey AR13	19	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moycarkey AR15	4	Pit	60	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moycarkey AR15	6	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ballydavid AR26	228	Kiln	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Ballydavid AR26	188	Kiln	0	17	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0
Ballydavid AR26	232	Kiln	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ballydavid AR26	187	Kiln	0	20	0	0	9	0	0	0	3	0	2	0	0	0	0	0	0	0
Ballydavid AR26	221	Kiln	2	10	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0
Ballydavid AR26	234	Kiln	25	20	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Borris/Blackcastle AR31	95	Kiln	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	144	Kiln	0	15	0	0	0	0	7	0	0	0	0	0	0	4	0	0	0	0
Borris/Blackcastle AR31	183	Pit	33	56	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	289	Furnace	67	29	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Borris/Blackcastle AR31	302	Metalworking deposit	44	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	372	Kiln	21	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	437	Kiln	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	539	Ditch	16	2	0	0	30	0	0	0	0	0	0	2	0	0	0	0	0	0
Borris/Blackcastle AR31	583	Ditch	0	15	0	0	9	19	0	0	7	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	750	Kiln	27	12	2	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	756	Ditch	15	16	0	0	4	13	0	0	0	0	0	0	0	2	0	0	0	0
Borris/Blackcastle AR31	1070	Ditch	21	16	0	0	5	47	0	0	4	0	0	0	0	4	0	0	0	0
Borris/Blackcastle AR31	1020	Kiln	46	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	1039	Metalworking deposit	41	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0
Borris/Blackcastle AR31	1172	Slot trench	19	7	0	0	10	10	0	0	0	0	0	0	0	9	0	0	0	0
Borris AR33	304	Slot trench	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	362	Slot trench	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	418	Slot trench	7	5	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	1066	Slot trench	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	1663	Pit	24	63	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0
Borris AR33	848	Kiln	53	17	0	0	5	16	0	0	5	0	0	0	0	0	0	0	0	0
Borris AR33	898	Kiln	6	20	0	0	0	11	0	0	9	0	0	0	0	0	0	0	0	0
Borris AR33	54	Slot trench	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Borris AR33	1037	Pit	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	1599	Pit	0	4	4	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0
Borris AR33	1603	Pit	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	1629	Pit	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	205	Kiln	8	4	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	207	Kiln	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
Borris AR33	1411	Kiln	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	1414	Kiln	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	522	Kiln	5	29	4	0	16	31	0	0	0	0	0	0	0	17	0	0	0	0
Borris AR33	1236	Ditch	20	26	3	0	10	37	0	0	0	0	0	0	0	4	0	0	0	0
Borris AR33	1415	Pit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	1430	Posthole	0	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	1436	Slot trench	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	1529	Posthole	48	3	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	524	Pit	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	576	Pit	23	18	0	3	0	49	0	0	0	0	0	0	0	7	0	0	0	0
Borris AR33	1293	Ditch	60	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	1309	Pit	6	3	0	0	4	3	0	0	0	0	0	0	0	0	0	0	0	0
Borris AR33	1399	Pit	31	12	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 5	26	Kiln	0	21	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	2	Hearth	30	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	4	Hearth	1	11	0	1	0	11	0	5	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	6	Ditch	7	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	14	Linear	3	45	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	15	Posthole	8	23	10	0	2	0	0	0	0	1	6	0	0	0	0	0	0	0
Monadreela Site 8	16	Posthole	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	17	Ditch	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	20	Ditch	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Monadreela Site 8	10	Ditch	0	1	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	18	Linear	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	23	Ditch	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	19	Kiln	13	21	0	0	2	14	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 8	22	Ditch	0	0	0	21	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 9	12	Hearth	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 9	16	Posthole	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 9	15	Floor deposit	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
Monadreela Site 9	28	Slot trench	0	2	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 9	36	Posthole	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 9	37	Pit	32	20	10	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 9	35	Ditch	50	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 9	29	Ditch	0	0	0	40	1	14	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 9	10	Ditch	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 9	17	Ditch	0	0	0	0	4	43	0	0	3	0	0	0	0	0	0	0	0	0
Monadreela Site 9	38	Ditch	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0
Monadreela Site 9	39	Ditch	0	12	1	65	5	1	0	0	0	0	6	0	0	0	0	0	0	0
Monadreela Site 9	40	Ditch	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	4	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	5	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	6	Pit	48	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Monadreela Site 11	7	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	15	Pit	22	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	8	Pit	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	9	Pit	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	10	Pit	22	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	11	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	12	Pit	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Monadreela Site 11	13	Pit	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	14	Pit	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	17	Pit	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	18	Pit	0	7	9	0	2	0	0	0	0	3	0	0	0	1	0	0	0	0
Monadreela Site 11	23	Pit	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	48	Kiln	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	49	Kiln	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	50	Kiln	0	0	0	0	0	7	0	8	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	62	Kiln	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	63	Kiln	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	65	Kiln	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	88	Hearth	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	90	Deposit	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	94	Slot trench	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	109	Slot trench	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	95	Slot trench	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	102	Slot trench	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	103	Slot trench	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	96	Slot trench	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	97	Slot trench	0	2	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Monadreela Site 11	98	Slot trench	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	99	Slot trench	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	100	Slot trench	0	7	13	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	101	Slot trench	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 11	104	Slot trench	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 12	2	Pit	6	0	8	21	13	0	0	0	2	0	0	0	0	0	0	0	0	0
Monadreela Site 12	1	Ditch	0	0	0	24	15	0	0	0	0	0	0	0	0	0	0	0	0	0
Monadreela Site 12	3	Ditch	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Boscabell Sie 19	28	Kiln	37	9	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	29	Kiln	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	30	Deposit	7	0	0	22	7	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	9	Pit	9	19	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	17	Pit	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	7	Pit	0	39	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	23	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	26	Pit	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	8	Posthole	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	10	Posthole	0	27	4	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	11	Posthole	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 19	33	Ditch	48	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	3	Pit	39	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	4	Pit	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	7a	Pit	0	37	5	0	7	0	0	0	1	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	7b	Pit	0	12	1	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0
Boscabell Sie 20	8	Pit	0	29	4	0	14	0	0	0	3	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	9	Pit	9	12	11	0	0	0	0	0	14	0	0	0	4	0	0	0	0	0
Boscabell Sie 20	10	Pit	43	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	27	Pit	7	7	0	0	19	0	0	0	0	3	0	0	0	0	0	0	0	0
Boscabell Sie 20	13	Pit	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	14	Pit	0	7	3	0	4	0	0	0	4	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	17	Pit	8	27	11	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	18	Pit	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	23	Pit	0	7	9	15	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Boscabell Sie 20	24	Pit	0	33	20	0	6	3	0	0	0	0	0	0	1	0	0	0	0	0
Boscabell Sie 20	25	Pit	0	30	11	0	8	0	5	0	0	0	0	1	0	0	0	0	0	0
Hughes' Lot East Site 25ii	123	Stakehole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Hughes' Lot East Site 25ii	128	Stakehole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	108	Stakehole	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	112	Stakehole	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	115	Stakehole	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	118	Stakehole	0	3	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	125	Stakehole	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	90	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	94	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	101	Posthole	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	109	Stakehole	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	103	Posthole	0	0	14	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	105	Posthole	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	117	Stakehole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	000A	Posthole	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	95	Pit	4	19	10	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	96	Posthole	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	102	Posthole	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	104	Posthole	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	116	Stakehole	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	119	Posthole	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	122	Posthole	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	127	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	6	Posthole	0	4	7	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	7	Posthole	0	41	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	8	Posthole	6	31	0	0	0	7	0	0	6	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	12	Posthole	0	13	5	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	13	Posthole	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	17	Posthole	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Hughes' Lot East Site 25ii	24	Posthole	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	25	Posthole	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	120	Posthole	0	11	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	27	Posthole	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	99	Posthole	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	100	Posthole	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	162	Posthole	15	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	181	Ditch	12	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	187	Ditch	0	9	31	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	189	Ditch	0	11	21	20	0	9	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	56	Posthole	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	66	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	67	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	75	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	76	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	59	Posthole	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	69	Posthole	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	19	Posthole	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	20	Posthole	7	0	13	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0
Hughes' Lot East Site 25ii	21	Posthole	0	27	0	0	0	14	0	0	6	0	0	0	3	0	0	0	0	0
Hughes' Lot East Site 25ii	36	Posthole	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	37	Posthole	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	82	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	84	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	85	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	86	Posthole	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	89	Posthole	0	0	6	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	111	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Hughes' Lot East Site 25ii	113	Posthole	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	114	Posthole	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	121	Posthole	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	129	Posthole	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	130	Posthole	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	132	Posthole	0	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	3	Kiln	7	0	6	0	27	0	0	0	10	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	9	Kiln	13	0	0	0	4	19	0	27	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	147	Kiln	0	0	0	0	4	19	0	27	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	34	Kiln	0	45	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	35	Kiln	7	16	45	9	0	8	0	0	0	5	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	000B	Kiln	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	138	Kiln	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	139	Kiln	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	140	Kiln	4	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	141	Kiln	0	0	0	0	0	0	0	0	0	8	0	0	0	3	0	0	0	0
Hughes' Lot East Site 25ii	142	Kiln	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0
Hughes' Lot East Site 25ii	143	Kiln	0	16	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	144	Kiln	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	145	Kiln	0	14	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	15	Pit	11	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	16	Pit	9	0	0	0	0	31	0	0	10	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	14	Pit	0	28	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	15	Pit	4	34	11	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	41	Pit	0	0	5	5	0	7	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	49	Pit	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	55	Pit	0	24	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	110	Pit	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Hughes' Lot East Site 25ii	146	Pit	19	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	78	Pit	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	87	Pit	0	0	0	0	0	6	0	0	4	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	2	Hearth	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	77	Pit	41	5	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	57	Pit	2	6	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0
Hughes' Lot East Site 25ii	68	Pit	0	12	0	0	0	7	5	0	0	0	0	7	2	0	0	0	0	0
Hughes' Lot East Site 25ii	81	Pit	11	7	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	148	Hearth	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	149	Hearth	11	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	150	Hearth	4	0	27	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	152	Hearth	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	153	Hearth	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	131	Pit	4	7	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	22	Slot trench	2	0	0	0	0	15	4	0	0	0	0	0	3	0	0	0	0	0
Hughes' Lot East Site 25ii	39	Slot trench	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	28	Kiln	15	8	0	0	19	5	0	0	3	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	29	Kiln	12	17	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	30	Kiln	0	0	78	0	0	8	0	8	0	0	0	0	3	0	0	0	0	0
Hughes' Lot East Site 25ii	46	Ditch	0	5	4	0	7	27	0	0	7	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	72	Ditch	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	61	Ditch	28	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	62	Ditch	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	63	Ditch	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	64	Ditch	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	71	Ditch	0	0	5	8	0	2	0	0	0	3	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	79	Ditch	0	6	2	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	107	Ditch	10	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Hughes' Lot East Site 25ii	31	Ditch	0	0	0	44	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	42	Ditch	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	43	Ditch	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	47	Ditch	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	48	Ditch	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	44	Ditch	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	93	Ditch	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	53	Ditch	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	133	Ditch	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	4	Ditch	0	5	18	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	32	Grave	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	5	Ditch	0	5	3	0	7	35	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	33	Ditch	0	0	15	8	0	0	0	0	0	4	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	88	Furrow	0	7	0	0	0	10	0	7	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	92		0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	154	Ditch	3	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	80	Ditch	0	0	0	5	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	73	Ditch	3	0	0	0	0	15	32	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	10	Ditch	0	0	0	0	12	12	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	163	Ditch	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	80	Hearth	0	11	0	0	12	3	0	0	0	0	0	4	0	0	0	0	0	0
Hughes' Lot East Site 25ii	18		50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	40	Furrow	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25ii	45	Ditch	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iii	49	Ditch	40	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iii	28	Ditch	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	1	Posthole	0	23	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	2	Posthole	0	22	11	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Hughes' Lot East Site 25iv	3	Pit	32	9	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	4	Pit	12	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	5	Posthole	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	7	Pit	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	8	Kiln	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	9	Pit	0	20	0	0	0	15	0	5	0	7	0	3	0	0	0	0	0	0
Hughes' Lot East Site 25iv	11	Posthole	0	7	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	10	Pit	0	2	0	0	0	4	0	0	0	0	0	0	0	3	0	0	0	0
Hughes' Lot East Site 25iv	13	Kiln	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	14	Kiln	38	0	6	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	15	Kiln	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	16	Kiln	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	17	Kiln	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	18	Kiln	25	14	0	6	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	19	Kiln	39	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	21	Kiln	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hughes' Lot East Site 25iv	22	Kiln	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	8	Pit	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	3	Basal fill pit	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	4	Basal fill of pit	28	3	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	2	Upper fill of pit	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	5	Single fill of grave cut	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	12	Pit	3	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	11	Pit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	15	Pit	0	16	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	13	Pit	0	0	3	42	0	0	0	0	0	5	0	0	0	0	0	0	0	0
Farranamanagh	19	Pit	14	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	17	Pit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Farranamanagh	21	Ditch	1	15	0	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0
Farranamanagh	23	Pit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	24	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	29	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	31	Upper fill of possible pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	35	Middle fill of possible pit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	34	Slot trench	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	45	Posthole	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	60	Slot trench	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	44	Ditch	24	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	51	Ditch	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	47	Ditch	4	0	0	8	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	48	Posthole	48	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	58	Posthole	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farranamanagh	59		0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Windmill	2	Pit	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Windmill	1	Pit	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Windmill	4	Posthole	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Windmill	8	Posthole	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0
Windmill	7	Posthole	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Windmill	3	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Windmill	6	Pit	0	0	1	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0
Windmill	5	Posthole	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	1	Linear	4	42	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Toureen Peckaun	2	Pit	22	0	8	11	2	5	0	0	2	0	0	0	0	0	0	0	0	0
Toureen Peckaun	3	Deposit	8	0	7	11	24	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	4	Posthole	13	6	7		7	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Toureen Peckaun	5	Drain	14	0	8	15	1	12	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	6	Drain	12	7	19	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	7	Deposit	20	0	7	16	0	7	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	8	Deposit	12	7	0	11	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	9	Postpipe	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	10	Linear	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	11	Posthole	7	5	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	12	Deposit	0	13	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	13	Posthole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	14	Posthole	4	0	9	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	15	Fence_fill	7	0	5	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	16	Posthole	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	17	Posthole	0	30	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	18	Deposit	0	0	36	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	19	Posthole	0	11	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	20	Deposit	0	1	39	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	21	Linear	0	0	44	0	5	0	0	0	1	0	0	0	0	0	0	0	0	0
Toureen Peckaun	22	Posthole	0	3	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	23	Drain	12	7	0	11	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	24	Posthole	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	25	Posthole	44	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	26	Fence_fill	0	31	8	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	27	Fence_fill	0	42	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	28	Posthole	3	44	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	29	Posthole	34	7	5	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Toureen Peckaun	30	Fence_fill	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	31	Fence_fill	13	26	7	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
Toureen Peckaun	32	Fence_fill	44	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Tipperary																				
Toureen Peckaun	33	Stakehole	0	0	42	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0
Toureen Peckaun	34	Fence_fill	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	35	Pit	4	38	0	0	6	0	0	0	0	2	0	0	0	0	0	0	0	0
Toureen Peckaun	36	Posthole	0	13	27	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	37	Ditch	7	42	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Toureen Peckaun	38	Postpipe	36	0	0	0	12	0	0	0	1	1	0	0	0	0	0	0	0	0
Toureen Peckaun	39	Ditch	30	0	2	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	40	Fence_fill	0	0	11	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	41	Slot trench	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	42	Posthole	0	7	30	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Toureen Peckaun	43	Pit	12	29	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	44	Well	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	45	Pit	1	15	28	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
Toureen Peckaun	46	Slot trench	43	0	2	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	47	Deposit	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	48	Kiln	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	49	Kiln	34	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	50	Hearth	45	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	51	Pit	0	14	28	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	52	Pit	10	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	53	Deposit	33	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	54	Deposit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	55	Deposit	49	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	56	Posthole	2	12	3	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	57	Posthole	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toureen Peckaun	58	Posthole	0	7	37	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Kilkenny																				
Baysrath	1	Ditch	0	5	3	0	0	0	28	0	14	0	0	0	0	0	0	0	0	0
Baysrath	15	Deposit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 2	1	Slot trench	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 2	29	Slot trench	22	0	4	0	6	0	0	0	0	5	0	0	0	0	0	0	0	0
Tinvaun Site 3	1	Ditch	0	2	3	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	29	Pit	45	3	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	36	Slot trench	48	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	50	Slot trench	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	23	Posthole	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	14	Posthole	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	28	Slot trench	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	28	Slot trench	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	77	Deposit	44	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Tinvaun Site 3	53	Posthole	0	10	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
Tinvaun Site 3	37	Stakehole_fill	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	55	Hearth_fill	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	41	Hearth	48	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	52	Posthole	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	62	Posthole	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinvaun Site 3	68	Posthole	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	32	Pit	49	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	33	Pit	0	0	6	42	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Knockadrina	35	Pit	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	36	Posthole	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	38	Slot trench	3	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	114	Pit	48	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Knockadrina	115	Pit	11	21	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	118	Pit	0	46	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Kilkenny																				
Knockadrina	113	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	48	Ditch	2	0	0	1	12	10	0	0	25	0	0	0	0	0	0	0	0	0
Knockadrina	49	Ditch	0	0	0	13	0	25	0	0	12	0	0	0	0	0	0	0	0	0
Knockadrina	55	Ditch	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	6	Ditch	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	102	Ditch	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	104	Ditch	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	92	Ditch	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	88	Linear	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	90	Linear	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
Knockadrina	101	Linear	0	3	42	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	105	Pit	0	0	0	26	11	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	11	Slot trench	0	33	2	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	79	Posthole	7	0	0	0	43	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	61	Posthole	4	30	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	62	Posthole	0	20	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	63	Posthole	1	1	1	10	28	9	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	67	Ditch	26	0	4	5	0	7	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	98	Ditch	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	84	Slot trench	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	69	Pit	0	6	0	0	0	44	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	95	Pit	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	5	Pit	0	4	40	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	72	Pit	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knockadrina	117	Kiln	40	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kellysgrange	5	Kiln	0	5	0	0	0	42	1	0	2	0	0	0	0	0	0	0	0	0
Kellysgrange	2	Posthole	0	10	1	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0
Kellysgrange	8A	Kiln	5	14	3	0	0	8	5	0	10	0	0	0	1	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Kilkenny																				
Kellysgrange	8B	Kiln	0	26	4	0	0	11	8	0	7	0	0	0	0	0	0	0	0	0
Kellysgrange	7	Kiln	0	22	2	0	5	10	0	0	10	0	0	0	1	0	0	0	0	0
Kellysgrange	11	Kiln	0	0	2	2	2	30	1	0	2	0	0	0	0	0	0	0	0	0
Kellysgrange	17	Kiln	1	10	5	2	0	10	5	0	6	0	0	0	1	0	0	0	0	0
Kellysgrange	18	Kiln	0	34	5	3	1	10	0	0	0	0	0	0	0	0	0	0	0	0
Kellysgrange	21	Kiln	4	4	31	1	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Kellysgrange	25	Kiln	29	3	15	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Kellysgrange	12	Kiln	3	34	3	0	0	3	6	0	0	0	1	0	0	0	0	0	0	0
Kellysgrange	22	Kiln	0	10	3	0	0	6	14	0	6	0	0	0	0	0	0	0	0	0
Kellysgrange	31	Kiln	0	9	0	0	2	0	21	0	5	0	0	0	0	0	0	0	0	0
Kellysgrange	28	Kiln	34	8	0	0	0	4	0	0	4	0	0	0	0	0	0	0	0	0
Kellysgrange	20	Kiln	0	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Kellysgrange	27	Kiln	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kellysgrange	32	Kiln	0	29	0	0	5	10	1	0	4	0	0	0	1	0	0	0	0	0
Kellysgrange	33	Kiln	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	7	Ditch	5	0	18	8	15	1	0	0	0	3	0	0	0	0	0	0	0	0
Holdenstown	8	Ditch	19	0	4	13	10	0	0	0	4	0	0	0	0	0	0	0	0	0
Holdenstown	9	Posthole	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	10	Posthole	13	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	11	Ditch	10	0	0	8	0	12	0	0	2	1	0	0	0	0	0	0	0	0
Holdenstown	12	Ditch	0	0	8	34	0	8	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	24	Ditch re-cut	13	0	0	11	0	9	0	0	15	0	0	0	2	0	0	0	0	0
Holdenstown	25	Ditch re-cut	3	0	2	33	7	0	0	0	1	0	0	0	0	0	0	0	0	0
Holdenstown	35	Ditch re-cut	0	0	0	44	0	0	0	0	5	1	0	0	0	0	0	0	0	0
Holdenstown	8	Grave	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	11	Pit	0	23	2	0	0	3	22	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	16	Posthole	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	21	Hearth	28	20	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Kilkenny																				
Holdenstown	26	Grave	1	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Holdenstown	174	Grave	2	12	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
Holdenstown	118	Kiln	0	38	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0
Holdenstown	111	Kiln	0	31	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0
Holdenstown	118	Deposit	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	108	Kiln	2	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	116	Kiln	0	26	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	114	Kiln	10	4	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	135	Hearth	10	0	0	0	4	15	10	0	6	0	0	0	0	0	0	0	0	0
Holdenstown	159	Grave	0	0	0	0	0	0	5	0	10	0	0	0	0	0	0	0	0	0
Holdenstown	169	Grave	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holdenstown	188	Grave	5	21	3	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Holdenstown	225	Grave	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Danesfort Site 5	214	Pit	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 5	152	Pit	20	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
Danesfort Site 5	109	Pit	18	0	7	0	0	20	0	0	5	0	0	0	0	0	0	0	0	0
Danesfort Site 5	125	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 5	14	Kiln	0	6	0	0	26	18	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 5	28	Kiln	6	14	1	0	1	1	0	0	26	0	0	0	0	0	0	0	0	0
Danesfort Site 5	42	Kiln	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 6	3	Stakehole	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 6	42	Pit	47	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Danesfort Site 6	18	Pit	45	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 6	30	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 6	19	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 6	35	Slot trench	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 6	36	Pit	0	4	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Danesfort Site 6	33	Pit	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Kilkenny																				
Danesfort Site 6	63	Pit	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 6	87	Pit	49	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Danesfort Site 6	4	Hearth	0	3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 6	3	Hearth	5	9	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 6	7	Hearth	0	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Danesfort Site 6	11	Pit	7	27	0	0	4	7	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	16	Ditch	0	0	0	0	0	0	0	0	5	0	0	0	2	0	0	0	0	0
Kilree Site 3	36	Pit	49	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	42	Pit	1	7	2	6	0	5	0	0	3	0	0	0	0	0	0	0	0	0
Kilree Site 3	50	Pit	42	1	0	1	0	1	0	0	1	0	0	4	0	0	0	0	0	0
Kilree Site 3	61	Pit	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Kilree Site 3	66	Grave	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Kilree Site 3	89	Kiln	11	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	90	Kiln	13	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	92	Posthole	3	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	116	Ditch	43	0	4	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Kilree Site 3	120	Ditch	0	0	1	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0
Kilree Site 3	133	Souterrain	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Kilree Site 3	134	Souterrain	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Kilree Site 3	147	Ditch	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	149	Kiln	6	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
Kilree Site 3	162	Ditch	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	175	Ditch	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	176	Posthole	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Kilree Site 3	183	Ditch	48	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	245	Deposit	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	254	Posthole	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	255	Grave	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Kilkenny																				
Kilree Site 3	328	Grave	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	329	Deposit	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	351	Pit	0	2	0	41	0	0	0	0	8	0	0	0	0	0	0	0	0	0
Kilree Site 3	368	Kiln	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
Kilree Site 3	377	Pit	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	414	Pit	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	415	Grave	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	418	Grave	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	422	Kiln	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	446	Posthole	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	454	Posthole	49	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	462	Posthole	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Kilree Site 3	467	Pit	47	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0
Kilree Site 3	472	Kiln	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	473	Souterrain	40	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Kilree Site 3	474	Souterrain	8	31	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	491	Souterrain	49	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	686	Souterrain	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	690	Souterrain	14	8	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	692	Souterrain	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	753	Souterrain	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Kilree Site 3	768	Souterrain	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Kilree Site 3	814	Souterrain	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Kilree Site 3	815	Ditch	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 3	64	Floor deposit	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 4	65	Kiln	0	40	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 4	90	Pit	22	0	0	0	0	0	10	0	5	0	0	0	0	0	0	0	0	0
Kilree Site 4	161	Pit	0	0	0	0	0	0	10	0	13	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Kilkenny																				
Kilree Site 4	144	Ditch	9	1	0	0	0	5	20	0	5	0	0	0	0	0	0	0	0	0
Kilree Site 4	8	Ditch	8	5	0	0	0	10	24	0	0	0	0	0	5	0	0	0	0	0
Kilree Site 4	81	Ditch	15	0	0	0	2	0	0	0	10	0	0	0	0	0	0	0	0	0
Kilree Site 4	99	Kiln	0	0	0	0	0	0	2	0	8	0	0	0	0	0	0	0	0	0
Kilree Site 4	135	Ditch	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 4	157	Ditch	43	1	0	0	5	0	0	0	0	2	0	0	0	0	0	0	0	0
Kilree Site 4	156	Posthole	24	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 4	154	Posthole	0	40	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 4	150	Slot trench	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 4	160	Pit	23	0	0	0	1	1	0	0	5	0	0	0	0	0	0	0	0	0
Kilree Site 4	166	Kiln	0	45	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 4	190	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kilree Site 4	189	Kiln	1	0	0	0	0	65	0	0	0	0	0	0	0	0	0	0	0	0
Templemartin	2	Kiln	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Templemartin	3	Kiln	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jordanstown	3	Kiln	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jordanstown	8	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jordanstown	23	Pit	13	3	0	0	5	0	0	0	0	0	0	0	3	0	0	0	0	0
Shankill	3	Kiln	14	0	0	0	2	0	0	0	0	9	0	0	0	0	0	0	0	0
Shankill	7	Kiln	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shankill	12	Hearth	46	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shankill	13	Hearth	46	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leggetsrath	15	Deposit	2	0	6	0	16	0	0	0	16	10	0	0	0	0	0	0	0	0
Leggetsrath	35	Posthole	26	0	3	9	0	0	12	0	0	0	0	0	0	0	0	0	0	0
Leggetsrath	67	Slot trench	12	0	3	0	0	7	28	0	0	0	0	0	0	0	0	0	0	0
Leggetsrath	26	Stakehole	0	0	0	0	2	0	0	0	8	1	0	0	0	0	0	0	0	0
Leggetsrath	44	Pit	2	0	0	0	0	1	11	0	0	0	0	0	0	0	0	0	0	0
Leggetsrath	128	Kiln	6	0	7	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Kilkenny																				
Leggetsrath	129	Kiln	7	0	0	0	5	0	0	0	38	0	0	0	0	0	0	0	0	0
Kellysmount	1	Linear	42	0	0	0	2	0	0	0	0	6	0	0	0	0	0	0	0	0
Kellysmount	22	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milltown	60	Pit	2	10	42	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0
Milltown	76	Kiln	0	5	3	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Milltown	27	Kiln	8	0	7	3	0	3	0	0	5	0	0	0	0	0	0	0	0	0
Milltown	29	Pit	0	6	5	3	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Milltown	30	Pit	1	35	39	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Milltown	102	Pit	0	35	3	10	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Milltown	37	Pit	100	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Milltown	48	Furnace	6	2	7	14	0	3	0	0	7	0	0	0	0	0	0	0	0	0
Milltown	66	Pit	0	5	2	39	2	0	2	0	0	0	0	0	0	0	0	0	0	0
Milltown	79	Pit	50	8	3	3	0	9	0	0	1	0	0	0	0	0	0	0	0	0
Milltown	40	Pit	12	25	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Milltown	47	Pit	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Milltown	104	Pit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
Milltown	4	Posthole	110	1	0	5	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Milltown	7	Posthole	31	1	3	0	3	0	0	0	5	0	0	0	0	0	1	0	0	0
Milltown	54	Furnace	25	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ballykeoghan	73	Kiln	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ballykeoghan	111	Kiln	4	5	1	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Ballykeoghan	49	Kiln	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ballykeoghan	64	Pit	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scart & Rahard	2	Kiln	47	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Scart	11	Kiln	44	4	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Scart	12	Kiln	18	13	15	0	0	0	0	0	2	0	0	1	1	0	0	0	0	0
Scart	14	Kiln	30	2	0	0	0	4	0	0	9	0	0	0	1	0	0	0	0	0
Scart	27	Linear	5	8	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0

Site Name	Sample number	Feature Type	Quercus sp.	Corylus avellana	Fraxinus excelsior	Alnus glutinosa	Salix sp.	Maloideae spp.	Prunus spinosa	Prunus avium	Prunus spp.	Betula sp.	Ulmus sp.	Taxus baccata	Ilex aquifolium	Euonymus europaeus	Ulex europaeus	Frangula alnus	Hedera helix	Carpinus sp.
Kilkenny																				
Scart	17	Kiln	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scart	18	Kiln	6	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0
Scart	24	Pit	60	1	5	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
Coolmore	7	Kiln	110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coolmore	10	Kiln	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coolmore	17	Kiln	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Earlsrath	4	Pit	55	0	0	5	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Earlsrath AR30	12	Pit	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Earlsrath	21	Ditch	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Earlsrath	49	Dith	4	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Earlsrath	2	Deposit	41	6	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Earlsrath	4	Deposit	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rahard West	2	Hearth	99	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rahard West	8	Ditch	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Riceland	1	Pit	46	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Carlow																				
Moanduff Site 1	32	Kiln	11	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moanduff	38	Stakehole	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moanduff	37	Trough_fill	46	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moanduff	5	Hearth	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moanduff	126	Kiln	0	12	4	10	0	4	0	0	10	0	0	4	0	0	0	0	0	0
Moanduff	112	Kiln	1	6	7	13	0	4	0	0	19	0	0	0	0	0	0	0	0	0
Coneykeare	4	Kiln	25	21	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coneykeare	7	Posthole	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coneykeare	16	Posthole	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Coneykeare	22	Posthole	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coneykeare	42	Ditch	10	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Appendix. 4 List of radiocarbon dates (AMS) from all sites

Site name	Context no. (fill)	Lab code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Material dated	Species identification	Context
Gortmakellis AR01 E2356	119	UBA11639	1204	20	772	888	-22.7	Charred cereal grain	Triticum sp.	Fill of kiln 91
Gortmakellis AR01 E2356	57	UBA11631	1152	26	780	971	-22.1	Charred cereal grain	Hordeum sp.	Fill of ditch
Gortmakellis AR01 E2356	36	UBA11633	943	19	1029	1155	-22.6	Charred cereal grain	Hordeum sp.	Fill of double ditch
Gortmakellis AR01 E2356	307	UBA11635	1184	17	778	890	-20.3	Charred cereal grain	Hordeum sp.	Fill of ditch
Gortmakellis AR01 E2356	76	UBA11636	1191	18	772	885	-24.2	Charred cereal grain	Triticum sp.	Fill of enclosure ditch
Gortmakellis AR01 E2356	381	UBA11638	1240	22	687	868	-22.6	Charred cereal grain	Hordeum sp.	Fill of enclosure ditch
Gortmakellis AR01 E2356	227	UBA11077	1223	25	694	884	-22.7	Charred cereal grain	Hordeum sp.	Fill of central hearth
Gortmakellis AR01 E2356	127	UBA12670	1256	25	673	859	-30.0	Charred cereal grain	Avena sp.	Fill of burnt pit
Gortmakellis AR01 E2356	355	UBA11637	1213	20	722	885	-21.8	Charred cereal grain	Triticum sp.	Basal fill of ditch
Moycarkey AR12 E2365	11	UBA10354	963	31	1020	1155	-18.3	Charcoal	Quercus sp.	Charcoal production pit 2
Moycarkey AR13 E2366	22	UBA10355	984	30	991	1154	-27.3	Charcoal	Quercus sp.	Fill of pit 6
Moycarkey AR15 E2367	4	UBA10357	578	29	1302	1418	-23.1	Charcoal	Quercus sp.	Fill of pit 9
Moycarkey AR15 E2367	16	UBA10356	550	30	1326	1433	-22.9	Charcoal	Quercus sp.	Fill of pit 6
Ballydavid AR26 E2370	81	UBA11078	1587	22	422	537	-22.3	Charred cereal grain	Hordeum sp.	Fill of kiln 287
Borris Blackcastle AR31 E2374	2133	UBA12872	241	23	1636	1951	26.4	Charred cereal grain	Hordeum sp.	Basal fill of ditch
Borris Blackcastle AR31 E2374	1441	UBA12873	306	22	1495	1648	-27.3	Charcoal	Corylus avellana	Single fill of ditch
Borris Blackcastle AR31 E2374	1022	UBA12874	206	28	1521	1951	-25.7	Charcoal	Corylus avellana	Single fill of ditch
Borris Blackcastle AR31 E2374	2044	UBA12875	358	28	1452	1634	-23.6	Charcoal	Corylus avellana	Basal fill of metal working smithy
Borris Blackcastle AR31 E2374	539	UBA12876	622	31	1291	1399	-26.3	Charcoal	Fraxinus excelsior	Basal fill of furnace
Borris Blackcastle AR31 E2374	2708	UBA12877	598	27	1298	1409	-21.0	Charred cereal grain	Triticum sp.	Basal fill of stone lined kiln
Borris Blackcastle AR31 E2374	662	UBA12878	840	28	1156	1262	-15.3	Charred cereal grain	Triticum sp.	Basal fill of kiln
Borris Blackcastle AR31 E2374	191	UBA12879	377	23	1447	1629	-16.9	Charcoal	Prunus spinosa	Basal fill of kiln
Borris Blackcastle AR31 E2374	3356	UBA12882	768	29	1219	1280	-16.7	Charcoal	Salix spp.	Clay walled structure
Borris AR33 E2376	874	UBA10017	1241	28	686	870	-21.7	Animal bone		Fill of pit
Borris AR33 E2376	752	UBA12508	907	21	1039	1205	-25.8	Charcoal	Fraxinus excelsior	Single fill of wall slot of structure 2 in interior of enclosure A
Borris AR33 E2376	785	UBA12495	1337	22	648	765	-27.0	Charcoal	Fraxinus excelsior	Single fill of wall slot of structure 1 in interior of enclosure A

Site name	Context no. (fill)	Lab code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Material dated	Species identification	Context
Borris AR33 E2376	2074	UBA12504	1257	23	673	856	-26.7	Charred cereal grain	Hordeum sp.	Middle fill of charcoal rich pit to north of enclosure A
Borris AR33 E2376	1148	UBA12502	1300	2	662	771	-26.3	Charred cereal grain	Hordeum sp.	Lower fill of kiln C north of Enclosure A
Borris AR33 E2376	131	UBA12501	1272	18	680	774	-26.1	Charcoal	Quercus sp.	Single fill of smithing hearth cut into top of Enclosure B ditch
Borris AR33 E2376	1416	UBA12505	1165	18	779	947	-26.7	Charcoal	Betula sp.	Single fill of wall slot of structure 5 in interior of enclosure B
Borris AR33 E2376	2036	UBA12496	1209	25	724	887	-25.0	Charred cereal grain	Hordeum sp.	Basal fill of roasting pit, interior Enclosure B
Borris AR33 E2376	921	UBA12498	1039	21	892	989	-24.8	Charred cereal grain	Hordeum sp.	Basal fill from kiln B, in interior of enclosure C
Borris AR33 E2376	193	UBA12497	1101	22	892	989	-23.0	Charred cereal grain	Triticum sp.	Middle fill of ditch, enclosure C south
Borris AR33 E2376	637	UBA12499	1045	21	905	1024	-26.1	Charred cereal grain	Hordeum sp.	Basal fill of the conjoined pits to south of Enclosure C
Borris AR33 E2376	1971	UBA12507	1516	29	433	614	-24.2	Charcoal	Quercus sp.	Single fill of wall slot of structure 6 in interior of enclosure C
Borris AR33 E2376	1796	UBA12509	1240	18	688	866	-25.7	Charcoal	Maloideae spp.	Posthole from structure 7, interior enclosure C
Borris AR33 E2376	933	UBA12500	1213	23	717	887	-25.9	Charred cereal grain	Avena sp.	Basal fill of metalworking feature
Borris AR33 E2376	1248	UBA12503	1124	18	887	976	-23.1	Charred cereal grain	Hordeum sp.	Basal fill of stone lined pit (associated with metalworking complex)
Borris AR33 E2376	1632	UBA12506	2123	20	203	56	-29.0	Charcoal	Salix sp.	Upper fill containing slag from Enclosure D
Monadreela Site 5 (03E0279)	167	UBA13705	1284	18	671	730	-27.8	Charcoal	Fraxinus excelsior	Basal fill of kiln
Monadreela Site 5 (03E0279)	167	UBA13706	1163	19	779	953	-27.2	Charcoal	Fraxinus excelsior	Fill of kiln
Monadreela Site 8 (03E0299)	101	UBA13715	781	24	1218	1275	-26.1	Charred cereal grain	Hordeum sp.	Upper fill of kiln
Monadreela Site 8 (03E0299)	102	UBA13716	880	49	1034	1252	-25.4	Charred cereal grain	Avena sp.	Basal fill of kiln
Monadreela Site 8 (03E0299)	198	UBA13895	856	28	1052	1257	-27.5	Charred cereal grain	Hordeum sp.	Basal fill of linear
Monadreela Site 8 (03E0299)	109	UBA13719	759	25	1223	1281	-24.0	Charred cereal grain	Avena sp.	Fill of ditch
Monadreela Site 8 (03E0299)	126	UBA13896	812	28	1176	1269	-26.2	Charcoal	Salix sp.	Fill of linear ditch
Monadreela Site 8 (03E0299)	109	UBA13718	770	24	1221	1278	-20.8	Charred cereal grain	Avena sp.	Fill of ditch
Monadreela Site 8 (03E0299)	210	UBA13897	792	28	1190	1278	-26.0	Charcoal	Prunus spp.	Fill of kiln
Monadreela Site 9 (03E0345)	9	UBA13722	807	21	1189	1270	-25.0	Charred cereal grain	Hordeum sp.	Fill of hearth
Monadreela Site 9 (03E0345)	139	UBA13899	894	30	1041	1215	-28.1	Charcoal	Corylus avellana	Fill of posthole
Monadreela Site 9 (03E0345)	181	UBA13724	818	20	1183	1263	-29.4	Charcoal	Maloideae spp.	Floor deposit of rectangular structure
Monadreela Site 9 (03E0345)	246	UBA13725	893	23	1044	1213	-27.4	Charcoal	Corylus avellana	Fill of pit
Monadreela Site 9 (03E0345)	258	UBA13726	730	21	1258	1291	-22.7	Charred cereal grain	Triticum sp.	Fill of boundary ditch
Monadreela Site 9 (03E0345)	261	UBA13900	816	24	1178	1266	-25.8	Charcoal	Corylus avellana	Basal fill of ditch

Site name	Context no. (fill)	Lab code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Material dated	Species identification	Context
Monadreela Site 11 (03E0346)	36	UBA13733	622	19	1293	1393	-22.0	Charcoal	Salix spp.	Single fill of pit
Monadreela Site 11 (03E0346)	45	UBA14372	1594	37	394	551	-23.8	Charred cereal grain	Avena sp.	Basal fill of kiln
Monadreela Site 11 (03E0346)	52	UBA13901	836	28	1160	1261	-26.6	Charred cereal grain	Avena sp.	Fill of hearth
Monadreela Site 12 (03E0393)	203	UBA13727	827	38	1057	1274	-22.7	Charred cereal grain	Avena sp.	Fill of ditch
Monadreela Site 12 (03E0393)	212	UBA13728	785	20	1219	1272	-22.9	Charred cereal grain	Hordeum sp.	Fill of ditch
Boscabell Site 19 (03E0426)	184	UBA13743	920	25	1030	1172	-26.9	Charred cereal grain	Avena sp.	Basal fill of kiln chamber
Boscabell Site 20 (03E0470)	24	UBA13745	1497	18	541	609	-27.4	Charcoal	Salix spp.	Fill of pit
Boscabell Site 20 (03E0470)	129	UBA13748	1048	25	899	1026	-25.1	Charcoal	Quercus spp.	Fill of pit
Boscabell Site 20 (03E0470)	155	UBA13749	1992	31	38	75	-24.5	Charcoal	Prunus spp.	Fill of pit
Boscabell Site 20 (03E0470)	235	UBA13751	1381	26	612	673	-27.2	Charcoal	Maloideae spp.	Basal fill of pit
Hughes' Lot East Site 25ii (03E0730)	713	UBA13920	1219	23	710	886	-24.8	Charcoal	Quercus spp.	Stakehole within inner ringfort ditch
Hughes' Lot East Site 25ii (03E0730)	720	UBA13919	1215	24	713	887	-23.8	Charcoal	Quercus spp.	Pit associated with ancillary structure within inner enclosure
Hughes' Lot East Site 25ii (03E0730)	26	UBA13908	1083	32	894	1016	-25.4	Charcoal	Taxus baccata	Isloated postholes
Hughes' Lot East Site 25ii (03E0730)	765	UBA13921	1074	27	895	1019	-27.0	Charcoal	Quercus spp.	Isloated postholes
Hughes' Lot East Site 25ii (03E0730)	797	UBA13765	1192	24	772	993	-27.9	Charcoal	Fraxinus excelsior	Fill of crop drying kiln
Hughes' Lot East Site 25ii (03E0730)	402	UBA13762	1236	22	689	872	-23.0	Charcoal	Corylus avellana	Basal fill of crop drying kiln
Hughes' Lot East Site 25ii (03E0730)	402	UBA13763	1295	22	665	772	-28.5	Charcoal	Prunus spp.	Basal fill of crop drying kiln
Hughes' Lot East Site 25ii (03E0730)	795	UBA13916	1416	25	597	660	-26.0	Charcoal	Fraxinus excelsior	Spread/pit
Hughes' Lot East Site 25ii (03E0730)	384	UBA13761	1097	27	890	1012	-28.6	Charcoal	Maloideae spp.	Fill of foundation slot trench
Hughes' Lot East Site 25ii (03E0730)	423	UBA13909	1399	30	559	669	-18.6	Charred cereal grain	Hordeum sp.	Rake out from kiln
Hughes' Lot East Site 25ii (03E0730)	534	UBA13910	1011	31	908	1151	-23.9	Charcoal	Prunus spp.	Fill of outer enclosure ditch
Hughes' Lot East Site 25ii (03E0730)	348	UBA16211	1145	22	782	974	-22.2	Animal bone		Basal fill of ditch
Hughes' Lot East Site 25ii (03E0730)	557	UBA16213	1259	29	670	892	-20.7	Animal bone		Ditch re-cut
Hughes' Lot East Site 25ii (03E0730)	568	UBA16215	1187	21	775	888	-22.2	Animal bone		Ditch fill
Hughes' Lot East Site 25ii (03E0730)	571	UBA13912	1201	32	708	938	-27.8	Charcoal	Alnus glutinosa	Fill of inner enclosure ditch
Hughes' Lot East Site 25ii (03E0730)	552	UBA13913	1246	23	683	828	-26.7	Charcoal	Salix spp.	Fill of inner enclosure ditch
Hughes' Lot East Site 25ii (03E0730)	566	UBA16216	1045	21	905	1024	-24.9	Animal bone		Ditch fill
Hughes' Lot East Site 25ii (03E0730)	426	UBA13918	1197	27	720	932	-23.0	Charred cereal grain	Avena sp.	Basal fill of ditch
Hughes' Lot East Site 25ii (03E0730)	320	UBA13922	908	22	1038	1205	-26.5	Charcoal	Maloideae spp.	Linear ditch
Hughes' Lot East Site 25ii (03E0730)	344	UBA16210	1134	40	779	990	-20.2	Animal bone		Ditch fill
Hughes' Lot East Site 25ii (03E0730)	471	UBA16212	1248	24	681	864	-19.5	Animal bone		Basal fill of ditch

Site name	Context no. (fill)	Lab code	14C date	14C date error	Cal AD 2δ start date	Cal AD 2δ end date	13C error	Material dated	Species identification	Context
Hughes' Lot East Site 25iii (03E0746)	305	UBA13774	1273	19	678	774	-25.9	Charcoal	Fraxinus excelsior	Fill of ditch
Hughes' Lot East Site 25iv (03E0807)	9	UBA13779	1488	20	542	622	-24.5	Charcoal	Betula spp.	Charcoal rich fill of posthole
Hughes' Lot East Site 25iv (03E0807)	46	UBA13780	1182	37	719	968	-25.2	Charred cereal grain	Avena sp.	Charocal clay fill of pit
Hughes' Lot East Site 25iv (03E0807)	154	UBA13777	1241	23	686	868	-26.1	Charred cereal grain	Hordeum sp.	Basal fill of corn drying kiln
Hughes' Lot East Site 25iv (03E0807)	164	UBA13774	1148	20	782	971	-28.1	Charcoal	Alnus glutinosa	Fill of corn drying kiln
Farranamanagh Site 39 (03E0757)	28	UBA16041	1205	29	709	893	-17.9	Human bone?		Single fill of grave cut
Farranamanagh Site 39 (03E0757)	104	UBA13808	1045	21	905	1024	-26.2	Charcoal	Quercus spp.	Middle fill of charcoal production pit
Windmill Site 35 (03E0424)	21	UBA13799	741	36	1217	1376	-26.3	Charcoal	Corylus avellana	Fill of posthole
Toureen Peckaun (05E0247)	1119	UBA16286	2278	33	401	209	-17.2	Charcoal	Alnus glutinosa	Deposit pre-dating alluvial layers
Toureen Peckaun (05E0247)	752	UBA 16285	1555	37	420	584	-23.8	Charcoal	Quercus spp.	Charcoal from Phase 1 terminal palisade post fill
Toureen Peckaun (05E0247)	441	UBA 16281	1305	40	649	801	-23.4	Charcoal	Fraxinus excelsior	Stake from Phase 2 fence.
Toureen Peckaun (05E0247)	159	UBA 7101	1303	32	658	769	-	Charcoal	Fraxinus excelsior	Fill of a palisade posthole
Toureen Peckaun (05E0247)	0039	UBA 7104	1299	32	660	769	-	Bone/antler/tooth	Unidentifed	Uppermost fill of second latest pit cut into backfilled linear feature.
Toureen Peckaun (05E0247)	154	UBA 7102	1263	32	667	864	-	Charcoal	Corylus avellana	Fill of pit near palisade.
Toureen Peckaun (05E0247)	129	UBA 7103	1261	32	668	865	-	Bone/antler/tooth	Unidentifed	Principal fill of large linear feature.
Toureen Peckaun (05E0247)	522	UBA 16279	1263	24	669	809	-27.6	Cremated bone	Burnt bone. Medium-sized mammal long bone fragments.	Fill of large pit.
Toureen Peckaun (05E0247)	177	UBA 7105	1255	31	672	867	-	Bone/antler/tooth	Burnt bone including sheep ph 1, 2 & 3 metapodial fragment	Uppermost fill of pit in 2006 extension of Trench C.
Toureen Peckaun (05E0247)	209	UBA 16280	1255	32	672	867	-25.0	Charcoal	Fraxinus excelsior	Late deposit overlying all the pits at centre of trench.
Toureen Peckaun (05E0247)	654	UBA 16296	1207	22	724	888	-27.4	Charred nutshell	Corylus avellana	Basal fill of ditch.
Toureen Peckaun (05E0247)	528	UBA 16284	1159	22	779	966	-21.9	Charcoal	Fraxinus excelsior	Fill of early rectilinear post.
Toureen Peckaun (05E0247)	421	UBA 16292	1064	43	888	1030	-22.3	Bone/antler/tooth	Right temporal.	Phase 2 grave.
Toureen Peckaun (05E0247)	508	UBA 16283	1088	22	894	1013	-28.1	Charcoal	Corylus avellana	Fill of post (later).
Toureen Peckaun (05E0247)	519	UBA 16295	1079	26	895	1017	-20.7	Bone/antler/tooth	Fragment of right maxilla.	Phase 1 grave.
Toureen Peckaun (05E0247)	368	UBA 16287	743	30	1223	1289	-14.9	Bone/antler/tooth	Left temporal	Phase 2 grave.
Toureen Peckaun (05E0247)	494	UBA16291	663	26	1278	1390	-21.1	Bone/antler/tooth	Fragment of left humerous.	Phase 2 grave.
Toureen Peckaun (05E0247)	417	UBA 16290	578	20	1310	1413	-22.5	Bone/antler/tooth	Fragment of left femur.	Phase 2 grave.
Toureen Peckaun (05E0247)	384	UBA 16289	429	44	1413	1630	-15.2	Bone/antler/tooth	Fragment of right tibia.	Phase 2 grave.

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Toureen Peckaun (05E0247)	502	UBA 16282	451	22	1421	1461	-18.6	Charcoal	Quercus spp.	Small posthole possibly relating to internal partitions of the Romanesque church.
Toureen Peckaun (05E0247)	490	UBA 16288	429	21	1435	1630	-20.8	Bone/antler/tooth	Fragment of right humerous.	Phase 2 grave.
Baysrath AR5354 (E2517)	18	UBA 10985	1152	28	780	971	-30.9	Charcoal	Fraxinus excelsior	Ditch C19
Baysrath AR5354 (E2517)	4	UBA 14020	174	21	1664	1952	-24.0	Bone/antler/tooth	Sheep/Goat rib fragment	Deposit over path
Baysrath AR5354 (E2517)	931	UBA-10687	1220	27	694	886	-21.5	Charred cereal grain	Avena sp.	Kiln kill
Baysrath AR5354 (E2517)	153	UBA-10687	1626	32	349	537	-23.4	Charred cereal grain	Hordeum sp.	Kiln kill
Baysrath AR5354 (E2517)	43	UBA-10697	1066	32	895	1022	-25.4	Charred cereal grain	Hordeum sp.	Kiln fill
Baysrath AR5354 (E2517)	457	UBA-10683	1540	19	432	575	-23.1	Charred cereal grain	Triticum sp.	Kiln fill (T-shape)
Tinvaun AR066 Site 3 (E3606)	51	UBA 12171	1227	22	694	880	-25.0	Charcoal	Corylus avellana	Slot trench C51
Tinvaun AR066 Site 3 (E3606)	68	UBA 12170	1245	22	684	865	-26.7	Charcoal	Quercus spp. (young branchwood)	Circular pit
Tinvaun AR066 Site 3 (E3606)	120	UBA 12173	1098	35	885	1017	-26.7	Charcoal	Carpinus spp.	Rectangular pit
Tinvaun AR066 Site 3 (E3606)	163	UBA 12172	1148	21	782	971	-30.4	Charcoal	Corylus avellana	Stakehole
Knockadrina Site 2 (E3611)	528	UBA 12180	1194	21	776	889	-28.4	Charcoal	Ilex aquifolium	Kiln C517
Knockadrina Site 2 (E3611)	369	UBA 15543	1324	22	654	767	-24.4	Charcoal	Prunus spp.	
Knockadrina Site 2 (E3611)	245	UBA 12177	1331	24	650	766	-25.5	Charcoal	Salix spp.	Pit C244
Knockadrina Site 2 (E3611)	395	UBA 12179	1211	20	724	886	-30.5	Charcoal	Fraxinus excelsior	Pit C394
Kellysgrange Site 3 (E3576)	16	UBA 12182	1381	24	615	671	-22.2	Charcoal	Corylus avellana	Kiln C43
Kellysgrange Site 3 (E3576)	38	UBA 12183	1261	22	673	772	-25.0	Charcoal	Fraxinus excelsior	Kiln C9
Kellysgrange Site 3 (E3576)	61	UBA 12184	1391	24	654	769	-25.5	Charcoal	Maloideae spp.	Base of Kiln C43
Holdenstown Site 1 (E3681)	8	UBA13659	1556	23	429	558	-24.7	Bone/antler/tooth	Human tibia	Burial 8
Holdenstown Site 1 (E3681)	28	UBA 15400	1567	23	426	558	-24.4	Charcoal	Salix spp.	Primary fill of re-cut Ringditch C1
Holdenstown Site 1 (E3681)	48	UBA 15402	1550	32	425	579	-26.4	Bone/antler/tooth	Human femur	Upper fill of re-cut Ringditch C1
Holdenstown Site 1 (E3681)	56	UBA 15404	1728	22	250	383	-23.5	Charcoal	Alnus glutinosa	Base fill Ringditch C2
Holdesntown Site 2 (E3630)	182	UBA 15407	1699	23	258	409	-27.1	Charred cereal grain	Hordeum sp.	Kiln
Holdesntown Site 2 (E3630)	94	UBA 13660	1496	22	537	624	-18.5	Bone/antler/tooth	Human femur	Burial 2
Holdesntown Site 2 (E3630)	97	UBA 13661	1443	22	577	649	-22.6	Bone/antler/tooth	Human femur	Burial 9
Holdesntown Site 2 (E3630)	144	UBA 13662	1506	21	465	616	-24.0	Bone/antler/tooth	Human femur	Burial 26
Holdesntown Site 2 (E3630)	157	UBA 13663	1478	21	550	635	-21.7	Bone/antler/tooth	Human femur	Burial 33
Holdesntown Site 2 (E3630)	166	UBA 13664	1454	27	562	648	-20.5	Bone/antler/tooth	Human tibia	Burial 35
Holdesntown Site 2 (E3630)	203	UBA 13665	1472	22	554	640	-20.1	Bone/antler/tooth	Human femur	Burial 39

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Holdesntown Site 2 (E3630)	365	UBA 13667	1569	22	427	537	-21.9	Bone/antler/tooth	Human femur	Burial 59
Holdesntown Site 2 (E3630)	489	UBA 13668	1477	22	550	636	-21.7	Bone/antler/tooth	Human femur	Burial 84
Holdesntown Site 2 (E3630)	491	UBA13669	1493	24	539	632	-19.7	Bone/antler/tooth	Human femur	Burial 85
Holdesntown Site 2 (E3630)	272	UBA 15406	1289	23	668	772	-21.4	Bone/antler/tooth	Cow tibia	Fill of stakehole
Danesfort Site 5 (E3456)	546	UBA 12196	1565	23	427	548	-28.6	Charcoal	Prunus spp.	Fill of pit
Danesfort Site 6 (E3538)	156	UBA 12201	848	23	1158	1254	-28.5	Charcoal	Corylus avellana	Pit
Danesfort Site 6 (E3538)	180	UBA 12202	724	26	1241	1379	-28.9	Charcoal	Quercus spp. (young twig)	Pit
Danesfort Site 6 (E3538)	62	UBA 14030	758	22	1225	1280	-17.4	Bone/antler/tooth	Sheep radius	Upper fill of pit
Kilree Site 3 (E3643)	4	UBA 13670	1229	26	691	881	-20.4	Bone/antler/tooth	Human femur	Burial 4
Kilree Site 3 (E3643)	62	UBA 14031	1251	28	676	866	-23.9	Bone/antler/tooth	Sheep/Goat metacarpal	Ditch C3
Kilree Site 3 (E3643)	94	UBA 13103	1039	19	978	1024	-24.7	Charcoal	Prunus spp.	Ditch C9; Sec 9
Kilree Site 3 (E3643)	375	UBA 12205	850	26	1058	1258	-27.3	Charcoal	Alnus glutinosa	Pit C374
Kilree Site 3 (E3643)	80	UBA 12208	1174	26	775	949	-32.0	Charcoal	Alnus glutinosa	Pit C410 in Ditch C9
Kilree Site 3 (E3643)	587	UBA 12209	1168	26	777	961	-29.0	Charcoal	Corylus avellana	Pit C559
Kilree Site 3 (E3643)	723	UBA 12210	1242	33	684	875	-24.8	Charcoal	Quercus spp. (young brushwood)	Souterrain cut C738
Kilree Site 3 (E3643)	767	UBA 12211	1304	29	659	772	-26.6	Charcoal	Prunus spp.	Souterrain cut C719
Kilree Site 3 (E3643)	798	UBA 12212	1262	23	671	807	-29.4	Charcoal	Prunus spp.	Souterrain cut C719
Kilree Site 3 (E3643)	803	UBA 13104	1214	19	722	884	-27.3	Charcoal	Prunus spp.	Souterrain C719
Kilree Site 3 (E3643)	28	UBA12213	414	28	1432	1617	-32.3	Charcoal	Salix spp.	Ditch C9; Sec 41
Kilree Site 3 (E3643)	860	UBA 12214	1309	23	658	770	-27.3	Charcoal	Corylus avellana	Souterrain cut C719
Kilree Site 4 (E3730)	86	UBA 15399	614	21	1297	1398	-25.7	Charcoal	Prunus spinosa	L-shaped ditch
Kilree Site 4 (E3730)	275	UBA 15397	1484	23	544	632	-19.7	Bone/antler/tooth	Human femur	Fill of grave cut
Kilree Site 4 (E3730)	271	UBA 15398	1777	22	139	336	-22.7	Charcoal	Quercus spp. (young brushwood)	Burnt post
Templemartin Site 1 (E3849)	5	UBA 14057	1669	29	259	430	-27.7	Charcoal	Corylus avellana	Kiln C3
Jordanstown Site 2 (E3851)	120	UBA 12236	1133	22	829	984	-26.8	Charcoal	Corylus avellana	Pit C119
Shankill Site 2 (E3738)	24/27	UBA 12237	775	17	1223	1274	-24.1	Charcoal	Ilex aqufolium	Deposit
Shankill Site 5 (E3850)	62	UBA 12239	523	18	1399	1436	-28.8	Charcoal	Corylus avellana	Hearth
Leggetsrath East Site 1 (E3734)	70	UBA 15447	587	24	1303	1411	-25.5	Charcoal	Prunus spp.	Spread
Kellysmount Site 5 (E3858)	5	UBA 14050	1455	21	569	645	-26.8	Charcoal	Prunus spp.	Curvilinear ditch C3
Milltown AR03-05 (E2499)	48	POZ26970	2005	35	100BC	80AD	-	Charrd cereal grain	Hordeum sp.	Fill of smelting furnace C84
Milltown AR03-05 (E2499)	24	POZ26967	1270	35	660	870	-	Nutshell	Hazelnut shell	Kiln chamber C81
Milltown AR03-05 (E2499)	52	POZ26972	1900	35	20	220	-	Nutshell	Hazelnut shell	Smelting furnace C101
Milltown AR03-05 (E2499)	10	POZ26974	1205	35	690	940	-	Charcoal	Prunus spinosa	Posthole C30

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Milltown AR03-05 (E2499)	14	POZ16965	1300	30	660	780	-	Charcoal	Prunus avium	Posthole C213
Milltown AR03-05 (E2499)	45	POZ26969	2110	35	350BC	40BC	-	Charcoal	Betula spp.	Fill of pit C107
Milltown AR03-05 (E2499)	17	POZ26966	1360	40	660	770	-	Charcoal	Alnus glutinosa	Furnace C123
Milltown AR03-05 (E2499)	42	POZ26968	85	30	1680	1930	-	Charcoal	Ulex	Ditch fill C104
Milltown AR03-05 (E2499)	116	POZ26973	2015	35	110 BC	70 AD	-	Charcoal	Prunus spp.	Smelting furnace C126
Milltown AR03-05 (E2499)	128	POZ26975	1455	35	550	660	-	Charred cereal grain	Hordeum sp.	Pit within kiln C122
Ballykeoghan AR10-12 (E2501)	150	UBA13980	1248	31	679	869	-	Charred cereal grain	Avena sp.	Kiln C149
Ballykeoghan AR10-12 (E2501)	221	UBA13983	1338	21	648	765	-	Charred cereal grain	Avena sp.	Kiln C221
Ballykeoghan AR10-12 (E2501)	143	UBA13979	1905	26	26	211	-	Charred cereal grain	Hordeum sp.	Cooking pit
Ballykeoghan AR10-12 (E2501)	9	UBA13974	1901	22	30	207	-	Charred cereal grain	Avena sp.	Refuse pit
Ballykeoghan AR10-12 (E2501)	107	UBA13977	896	24	1043	1212	-	Charred cereal grain	Avena sp.	Kiln fire spot
Ballykeoghan AR10-12 (E2501)	182	UBA13981	1120	22	887	982	-	Charred cereal grain	Avena sp.	Fill of pit
Ballykeoghan AR10-12 (E2501)	229	UBA13982	2055	26	165BC	3AD	-	Charred cereal grain	Hordeum sp.	Fill of cooking pit
Scart and Rahard A019 (E2504)	39	UBA13985	123	12	1681	1953	-	Charred cereal grain	Hordeum sp.	Fill of pit C37
Scart and Rahard A019 (E2504)	50	POZ25472	675	30	1270	1390	-	Charred cereal grain	Hordeum sp.	Primary fill of kiln bowl C45
Scart AR020 (E2505)	13	POZ25473	1125	30	810	1000	-	Charred cereal grain	Avena sp.	Primary fill of kiln C3
Scart AR020 (E2505)	36	POZ25579	1030	35	890	1120	-	Charred cereal grain	Avena sp.	Primary fill of kiln C1
Scart AR020 (E2505)	49	UBA13986	826	21	1173	1260	-	Charred cereal grain	Avena sp.	Fill of pit C53
Coolmore AR045 (E2514)	10	UBA14005	796	19	1216	1268	-	Charcoal	Quercus spp. (young oak)	Kiln chamber
Earlsrath AR030 (E2510)	59	UBA13482	1113	26	885	990	-	Charcoal	Quercus spp. (young oak)	Fill of ditch C3
Earlsrath AR030 (E2510)	78	UBA13483	1595	20	419	535	-	Charcoal	Quercus spp. (young oak)	Fill of ditch C75
Earlsrath AR030 (E2510)	64	UBA13485	1165	25	778	962	-	Charcoal	Corylus avellana	Fill of pit C63
Earlsrath AR033 (E3007)	10	UBA13481	637	23	1287	1394	-	Charcoal	Alnus glutinosa	Spread C10
Rahard West AR17-18 (2503)	2	UBA8965	881	22	1047	1218	-	Charcoal	Quercus spp.	Fill of hearth
Riceland AR01 (08E0135)	9	UBA15540	1555	25	429	562	-	Charred cereal grain	Hordeum sp.	Fill of melting furnace C65
Moanduff Site 1 (E3839)	198	UBA 13122	1334	22	650	765	-30.3	Charcoal	Alnus glutinosa	Pit
Moanduff Site 1 (E3839)	142	UBA 13124	1762	22	215	376	-29.6	Charcoal	Corylus avellana	Posthole
Moanduff Site 1 (E3839)	148	UBA 13123	432	19	1432	1472	-25.0	Charcoal	Maloideae spp.	Pit
Moanduff Site 2 (E3735)	285	UBA 12260	1759	19	140	385	-26.1	Charcoal	Quercus spp. (young branchwood)	Pit
Coneykeare Site 1 (E3683)	23	UBA 12245	1335	19	650	764	-27.4	Charcoal	Alnus glutinosa	Kiln C21
Coneykeare Site 1 (E3683)	48	UBA 12247	1333	19	651	765	-25.2	Charcoal	Corylus avellana	Posthole C10
Coneykeare Site 1 (E3683)	53	UBA 12246	1321	19	656	766	-25.1	Charcoal	Salix spp.	Posthole C47
Coneykeare Site 1 (E3683)	68	UBA 12248	1313	19	658	768	-26.4	Charcoal	Quercus spp. (young branchwood)	Posthole C69
Coneykeare Site 1 (E3683)	110	UBA 12249	1549	25	448	568	-26.8	Charcoal	Maloideae spp.	Internal ditch C8